Dillon Resource Area Resources Inventory:

Water Quality Survey
Blacktail Unit

1978

By

Montana Forest and Conservation
Experiment Station

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For

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DILLON RESOURCE AREA
RESOURCES INVENTORY:

WATER QUALITY SURVEY
Blacktail Unit

Prepared by:
G. Thomas Foggin, III
Thomas D. Reid
Silas J. Gilbert

Montana Forest and Conservation Experiment Station
University of Montana
Missoula, Montana 59812

Prepared For:

Department of the Interior
Bureau of Land Management
Dillon Resource Area
Dillon, Montana 59725

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INTRODUCTION

Watershed managers have traditionally been concerned with the quality of the waters that leave a watershed. As man modifies watersheds by various land use practices, disequilibrium in both the terrestrial and aquatic environments occurs. Problems result in controlling accelerated sediment and nutrient release from non-point sources within the basin. Stream water samples provide the investigator with insights into the general health of the patient. In an attempt to reduce watershed degradation, Congress recently mandated that local and regional agencies and authorities gather and assess environmental data for the lands and waters under their jurisdiction and authority. The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92M-500) was promulgated to require: 1) the assessment of the sources and extent of non-point pollution, and 2) the development of methods and procedures for controlling non-point pollution resulting from agricultural and silvicultural activities (FWPCAA, 1972).

In April, 1976, personnel from the Montana Forest and Conservation Experiment Station began a resource inventory in southwest Montana for the Bureau of Land Management. This integrated resources inventory was designed by Bureau personnel to provide environmental data on watershed, wildlife, and range resources within portions of Beaverhead, Deer Lodge, Madison and Silver Bow counties near Dillon, Montana. More specifically, the National Resource Lands in the Rochester, Blacktail, Tendoy Mountains, Dillon West, and Centennial Planning Units were inventoried. The environmental data obtained is to be incorporated into the Bureau's Planning System and into the Mountain Foothills Range Environmental Impact Statement.

The water quality study portion of the above resource inventory project included the monitoring of 42 temporary stream sampling stations located in 17 drainage basins within the inventory area. Stream discharge, suspended sediment, hydrochemical values and bacteria levels were monitored at each sampling station for the 1977 and 1978 hydrologic years. In addition, the macrobenthic invertebrate communities at each station were sampled, the results of which are reported elsewhere. This volume presents the results of the water quality study for Blacktail Planning Unit which inclues East Fork Blacktail Deer, Indian, Clark Canyon, East Fork Clark Canyon, Little Sage, Basin and Little Basin creeks.

METHOD

The basic experimental design of the water quality study, developed by Bureau personnel, includes the sampling scheme, field methods, and laboratory methods. Minor additions and modifications to the original design were subsequently incorporated into the study as field and laboratory conditions dictated or permitted. Specific comments on such alterations are included.

Inventory Design

The initial phase of the water quality study involved a stream reach inventory and channel stability evaluation of each designated stream reach. The method and procedures used during this evaluation are outlined in Pfankuch (1975). The stream reach ratings were completed during August and September, 1976.

The 42 stream sampling stations were established during September, 1976. The selection of each gaging station site was governed by criteria presented in Carter and Davidian (1968). Each stream sampling station included a staff gage, a crest-stage gage, and a max-min thermometer. A standard 3.3ft. staff gage was mounted to a fence post driven into the stream bed. A crest-stage gage was constructed of 3/4" diameter clear acrylic tubing, using modifications of the plans set forth in Buchanan and Somers (1968). This gage was afixed to the staff gage and fence post. The max-min thermometer was bolted within a piece of PVC pipe, laid on the stream bottom, and attached by a chain to a fence post.

In addition, a 15 unit precipitation gage network was established in the spring of 1977. A general purpose rain gage (forester type) was installed in a plywood frame at each designated sample location and placed in a clear, open site at a 12" height above ground level. This technique

conforms with that recommended by the World Meteorological Organization (World Meteorological Organization, 1969, as cited in Aldridge, 1976). Such a placement minimizes the error caused by wind eddying (Stringer, 1972, p. 29; Aldridge, 1976), and reduces the probability of disturbance or damage by livestock or vandals.

The stream and precipitation gage networks were monitored during the 1977 and 1978 hydrologic years. The basic design called for all stations to be visited on a prescribed schedule of weekly during peak runoff and monthly during low flow. The field seasons included: October - November, 1976; February and April - November, 1977; and March - September, 1978. The following water quality parameters were monitored as applicable. During each visit; stream discharge, suspended sediment, specific conductance, air temperature, water temperature, max-min water temperature, and precipitation were determined. Once a month, a water quality sample was taken for the following analyses; pH, alkalinity, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, ammonia, nitrite-nitrate, and ortho-phosphate. A second stream water sample was obtained for bacterial analysis to determine levels of total and fecal coliform.

Macrobenthic invertebrate inventories were also conducted at each stream sampling station during May, July, and September of each hydrologic year. Four individual square foot samples for the smaller streams and 6 samples for the larger streams were obtained during 1977, while 2 and 4 samples respectively were obtained for the streams during 1978.

Field Methods

Discharge values were determined by standard techniques using procedures described in Buchanan and Somers (1968). Stream velocities

were taken with a Gurley Pygmy type model 625 current meter. Sediment samples were obtained with a US DH-48 sediment sampler in conformance with procedures in Guy and Norman (1970). Water temperatures were recorded from Taylor max-min thermometers. Precipitation was collected in standard 7" rain gage (forester type). Specific conductance was measured with a Delta Scientific Model 1914 conductivity meter. Hydrochemical samples were collected in acid washed polyethylene liter bottles, which were filled to exclude air, and stored in an ice chest during transport to the laboratory. Microbiological samples were collected in 250 ml sterilized glass bottles and also stored in the ice chest. The macrobenthic invertebrate samples were taken with a Kahlsico stream-bed fauna sampler.

Laboratory Methods

Immediately upon arrival at the Dillon laboratory, each sample bottle was opened and an unfiltered sample was analyzed for pH and alkalinity respectively. The values obtained closely represent the values at the time of collection in the field (Brown, Skougstad, and Fishman, 1970, p. 129), while minimizing the potential for instrument damage during transport or carriage over back country roads or trails. This method has been adopted by several USDA Forest Service personnel (Aubertin, 1974; Snyder, et al., 1975). PH was measured using an Orion pH probe and an Orion 407 ion analyser. Akalinity was then determined by potentiometric titration to a preselected end point with a standard acid, as outlined in Brown, et al., (1970).

A 100 milliliter aliquot for ammonia analysis was then acidified with 0.8 milliter concentrated sulfuric acid and refrigerated (American

Public Health Assoc., 1976, p.42). The remainder of each stream sample was subsequently filtered through a 0.45 μm (micrometer) membrane filter and frozen. Membrane filters were soaked for 24 hours before using to remove any traces of soluble phosphate or nitrate (A.P.H.A., 1976 p. 472). Ammonia samples were analyzed on an Orion Ammonia electrode, model 95-10 (Orion Research Incorp., 1974). This analysis was routinely preformed in the Dillon laboratory on the final day of field collection.

Upon return to the Missoula laboratory the frozen samples were defrosted for analysis in the following order; 1) filterable orthophosphate; 2) nitrite-nitrate; 3) sufate; and 4) common metals. Procedures followed were adapted from Standard Methods for the Examination of Water and Wastewaters (A.P.H.A, 1976), with the exception of nitrate which was taken from Methods for Chemical Analysis of Water and Wastes (Environmental Protection Agency, 1976). All colorimetric tests were preformed on a dual beam spectrophotometer (Beckmann ACTA model III). All glassware was acid washed.

The Asorbic Acid method, procedure 425F, (A.P.H.A., 1976) was used for dissolved orthophosphate. Results are expressed as PO_4-P. Nitrite and nitrate were determined collectively since nitrite usually occurs in insignificant amounts in uncontaminated surface waters. The sum of the two represents total oxidized nitrogen and is expresses as nitrite plus nitrate-nitrogen. The Cadmium Reduction Method (E.P.A., 1976) was selected because of its low detection limits (10 μg/l). Sulfate was measured using the turbidimetric method, procedure 427C, (A.P.H.A., 1976). During the 1977 field season measurements were made on a spectrophotometer, but during 1978 a nephelometer (Turner Designs, Inc., medel #40) was used. Both

methods are recommended in the procedure, although it was found the nephelometer increased the precision of the test. Sodium, potassium, magnesium and calcium were run in that order by atomic absorption spectroscopy (A.P.H.A., 1976) using a Varian Techtron AA-5 spectrophotometer. Lanthanum chloride solution was added to the samples for magnesium and calcium analyses to prevent anionic interferences (EPA, 1976). Total dissolved solids and bicarbonate concentrations were determined from specific conductance and alkalinity values using calculations presented in Brown, et al., (1970).

Nitrogen levels, ie. ammonia and nitrite-nitrate, are consistantly at the minimum detection limit of the analysis. Ammonia levels are particularly suspect owing to the limitations of the instrument and the technique for the analysis. In interpreting results of ammonia analysis; a presence or absence of detectable ammonia approach should be used. Thus high levels of ammonia indicate that a source of ammonia is present in addition to those which are naturally occurring. Such levels are usually transitory and may vary in order of magnitude. Nitrite - nitrate values are also near the minimum detection limit; however, the nature of this analysis yields more precise results. These values, as a whole, tend to be generally lower than those expected under the environmental conditions encountered. Low phosphate values are to be expected and were confirmed by this study. The method for phosphate analysis selected is the procedure generally used when working in this low range of values. The other ions, ie. sulfate and the common metals, tended to be present in sufficient quantities so that no problems were encountered owing to the sensitivity of the analyses.

Water samples for microbiological examination were analyzed within six hours of collection (Millipore, 1975a). Fecal coliform were cultured, identified, and enumerated throughout the study by the membrane filter method described by Millipore (1975b). Total coliform bacteria were cultured,

identified, and enumerated by the membrane filter method (Millipore, 1975a), but with the modifications outlined below.

Total coliform data for 1977 were determined by counting the number of wet colonies that exhibited a visible green metallic sheen, either to the naked eye or at 1.5x magnification. Millipore (1975a) recommends the use of a 10x magnification dissecting microscope and that the colonies be dry. Geldreich (1975), however, indicates that there is no significant advantage to drying the colonies before counting. Without the 10x magnification, however it is probable that colonies growing close together were mistaken as being one colony, and colonies having a weak metallic sheen were not counted at all. This procedure would result in data that would underestimate the number of total coliform colonies present.

A modification of the membrane filter method was adopted in 1978 to minimize the problem of underestimating the total coliform colonies. In the previous year, only the wet colonies exhibiting a distinct green metallic sheen were designated as coliform bacteria (Millipore, 1975a), while those wet colonies having a "non-sheen" red color darker than the medium-permeated background had not been counted. The degree of pigmentation and sheen development of coliform colonies grown on M-Endo medium, however, is variable according to both species and biotype. Furthermore, the identification criteria, i.e. colonies having a green iridescence or metallic sheen, is highly subjective and may vary from technician to technician. Thus, some authors admit that "questionable colonies" may occur which need more technical procedures for verification. One such procedure is to inoculate questionable colonies into a lactose broth, incubate at 35°C. for 48 hours, and determine whether gas and acid have been produced (Geldreich, 1975).

Using the above technique, an estimate of the fraction of questionable colonies was determined for which the lactose test was positive. After testing a series of 26 non-sheen, red colonies representing a variety of recognizable colonial morphotypes from several different stations, 69 percent were found to be lactose positive within 48 hours. Additionally, 16 percent of all dark red colonies found on 369 membrane filter samples exhibited a characteristic green sheen. It was thus estimated that approximately 75 percent of all red colonies darker than their membrane filter background conformed to either the green-sheen or lactose-test definitions of coliform bacteria. During the 1978 field season, all red colonies, sheen and non-sheen darker than their membrane filter background that were detected with the use of 10x magnification dissecting microscope were counted as total coliform. This procedure had the potential of overestimating the bacterial count by approximately 30 percent. It should be emphasized, however, that bacterial counts are not absolute values, but only estimates of magnitudes. Geldreich (1966, p.35) evaluated the total coliform bacteria for 40 samples using both the membrane filter method and the "most probable number" method. The ratio of their results varied from a minimum of 0.42 to a maximum of 2.52 respectively.

Tabulated total and fecal coliform data for this study are expressed as arithmetic means of either two or three replicated subsamples. Although the total coliform levels for the 1977 field season, i.e. May through November, 1977, are underestimated, the fecal coliform data for the two years are commensurate.

Analytical Methods

Stream discharge values were determined from field data with the use of a computer program based upon the procedure outlined in Buchanan and Somers (1969). These measured discharge values were then used to generate a staff-discharge rating curve for each station using a linear regression program. In several instances, two rating curves were produced. Instant and crest stage discharge values for the two water years were then estimated from the respective staff-discharge rating curves.

The annual hydrograph and sediment loading graphs were plotted with a computer using field data. Missing data points, i.e. winter months, were estimated using available stream flow, precipitation, and sediment concentration data. Estimates of annual water yield and annual sediment yield were generated by a modification of the computer program used to determine stream discharge. In a few instances, unusually high or questionable sediment concentration values, apparently caused by cattle present within the stream environs at the time of sampling or by sampling or analytical error, represented long sampling periods, i.e. 30 days. Where such conditions occurred, an estimated "corrected" level was substituted inorder to generate a more approximate determination of the annual sediment yield. The relationships between measured values of suspended sediment vs stream discharge and specific conductance vs stream discharge were determined by linear regression and plotted using the computer programs.

STUDY AREA

Beaverhead County, Montana

Beaverhead County is located in the southwestern corner of Montana immediately southwest of Butte. Almost the entire county lies above 5,000 feet and is encircled on the north, west and south by the Continental Divide. The area is characterized by broad grassland and sagebrush covered valley bottoms and river terraces, while the flanks of the numerous mountain ranges grade into forest lands. The westernmost headwaters of the Missouri River drain the county to the northeast via the Big Hole and Beaverhead rivers. The forested mountain areas are generally administered by the Beaverhead National Forest of the USDA, Forest Service; the lower mountain slopes and terrace lands are managed by the Department of Interior's Bureau of Land Management; while the valley bottoms are mainly in private holdings. The land resources of the county are primarily allocated to the raising of livestock, although lumbering, mining, and recreation constitute secondary, but significant land uses.

The Bureau of Land Management's district office is located in Dillon, the county seat. The county contains five planning units administered by the Bureau. The Blacktail Planning Unit lies southeast of Dillon and includes the East Fork of Blacktail Deer Creek, Clark Canyon Creek, Little Sage, and Basin Creek sample watersheds.

Blacktail Creek Watershed

The Blacktail Creek sample basin encompasses the nearly 29,200 acres of the East Fork Blacktail Deer Creek watershed that lie upstream of the bridge crossing in Section 6, Township 11S, Range 5W (Figure 1). This study area includes the Lower Blacktail discharge monitoring sub-station, the Lower Blacktail water quality monitoring sub-station, and the Upper Blacktail and Indian stations. Local relief in this predominantly northwest facing basin ranges from approximately 6,800 feet to 10,600 feet elevation. The upper basin is mountainous and includes several valleys confined by high steep slopes. The lower portion of the basin is open and composed of rolling hills and partially dissected terraces lying above the broad flood-plain. The geology of the upper valley includes a complex of calcareous and non-calcareous sedimentary and metasedimentary materials and associated igneous intrusives. The lower valley is largely composed of Tertiary sediments. The mountainous areas are dominated by entisols, inceptisols, talus deposits, and rock outcrops. The lower valley is characterized by mollisols. The lower and middle slopes of the mountains are covered with forests, the higher slopes are thinly forested or above the effective tree-line. The lower valley is covered with sagebrush and grassland communities. Approximately 50 percent of the sample basin is administered by the Beaverhead National Forest, 35 percent is controlled by either the State of Montana or in private holdings, and the remaining 15 percent is managed by the Bureau of Land Management. Portions of the lower basin are administered by the Montana Department of Fish and Game as an elk winter range. The middle portion of the watershed is allocated for livestock grazing, while both the middle and upper reaches are used for recreational pursuits.

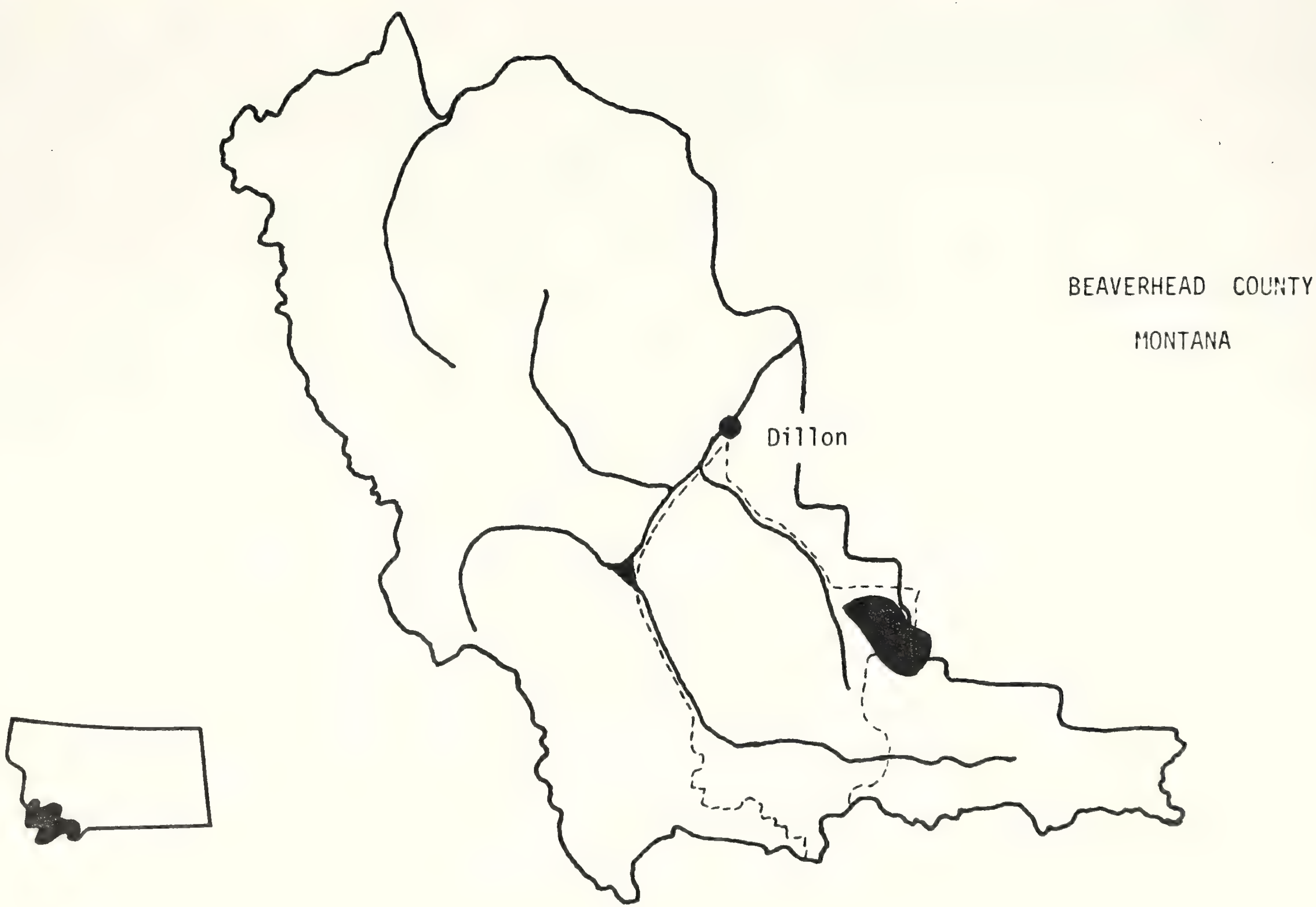

Figure 1. Location of Blacktail Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana.

Lower Blacktail Station

The Lower Blacktail station is divided into two sub-stations. The discharge monitoring sub-station No. 8(B) is located in the south central portion of Section 6, Township 11S, Range 5W (Figure 2), at the bridge where the road crosses East Fork Blacktail Deer Creek. This location is found on the Price Creek, N.E., Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 8B on aerial photo No. 5-119-147 of this resource inventory report and is shown on stream station photo No. 8(B)A. The station is located at 6,780 ft. elevation. The watershed above the station contains approximately 29,200 acres, has a local relief of 3,800 feet, and is oriented to the northwest. Approximately 50 percent of the watershed is forested. The water quality monitoring sub-station 8(A), is located in the northeast portion of Section 28, Township 11S, Range 5W (Figure 2), approximately 50 yards downstream from an unnamed drainage entering from the southwest. This location is found on the Price Creek N.E., Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 8A on aerial photo No. 14-120-73 of this resource inventory report. The station is located at 7,120 ft. elevation. The watershed above the station contains approximately 18,600 acres, has a local relief of 3,500 feet, and is oriented to the northwest. Approximately 75 percent of the watershed is forested.

Upper Blacktail Station

The Upper Blacktail station No. 6 is located in the southwest portion of Section 35, Township 11S, Range 5W (Figure 2), approximately 400 yards below the Beaverhead National Forest boundary. This location is found on the Antone Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 6 on aerial photo No.

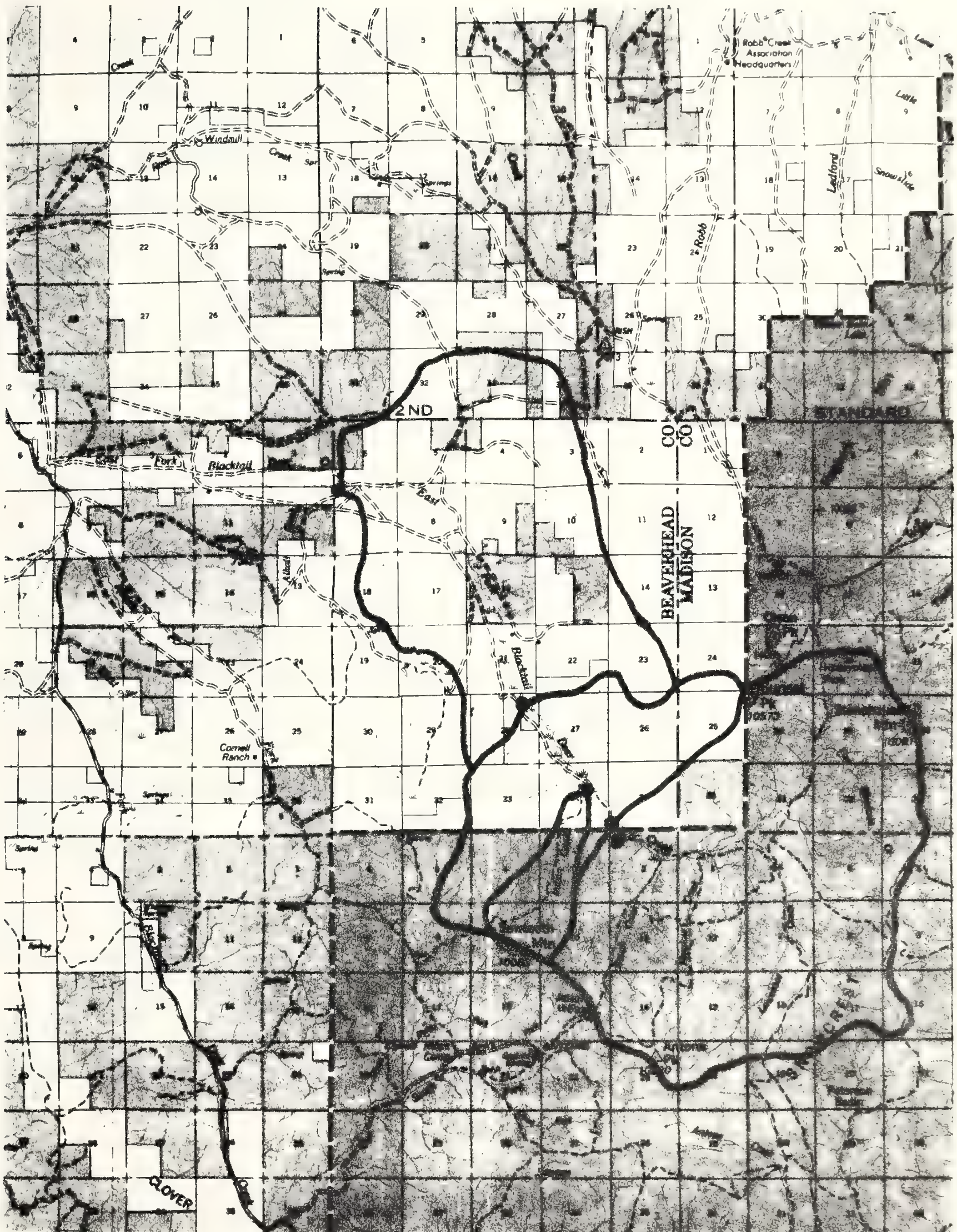

Figure 2. Locations of the Blacktail Creek Sampling Stations.

14-120-73 of this resource inventory report, and is shown on stream station photo no. 6A. The station is located at 7,350 ft. elevation. The watershed above the station contains approximately 13,900 acres, has a local relief of 3,100 feet, and is oriented to the northwest. Approximately 90 percent of the watershed is forested.

The Upper Blacktail precipitation station No. 6G is located in the southwest portion of Section 35, Township 11S, Range 5W (Figure 2), approximately 100 yards upstream from sample station No. 6, between the creek and the upper end of the beaver pond. It is depicted as site No. 6G on aerial photo No. 14-120-73 of this resource inventory report.

Indian Creek Station

The Indian Creek station No. 7 is located in the central portion of Section 34, Township 11S, Range 5W (Figure 2), approximately 50 yards upstream from where the road crosses Indian Creek. This location is found on the Antone Peak, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 7 on aerial photo No. 14-120-73 of this resource inventory report, and is shown on stream station photo no. 7A. The station is located at 7,310 ft. elevation. The watershed above the station contains approximately 1,100 acres, has a local relief of 2,800 feet, and is oriented to the north-northeast. Approximately 90 percent of the watershed is forested.

Clark Canyon Creek Watershed

The Clark Canyon Creek sample watershed (Figure 3) includes the Lower Clark Canyon, the Upper Clark Canyon, and the East Fork Clark Canyon sampling stations. This west-northwest oriented basin encompasses approximately

9,700 acres. Local relief in this steep and rugged basin ranges from nearly 5,650 feet to almost 8,900 feet. The basin's complex geology includes fine and course textured sedimentary materials, Tertiary sediments, as well as ash and mudflow deposits. The soils include inceptisols, mollisols, and alfisols. Grassland and sagebrush communities dominate the lower and mid-portions of the basin, while forests are found at favorable sites in the middle and upper reaches. The Bureau of Land Management administers approximately 65 percent of the watershed, 25 percent is in private holdings, while the remaining 10 percent belongs to the State of Montana. The basin is predominantly used for livestock grazing.

Lower Clark Canyon Station

The Lower Clark Canyon station No. 11 is located in the west central portion of Section 35, Township 9S, Range 10W (Figure 4), approximately 100 yards upstream from the section line. This location is found on the Dalys, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 11 on aerial photo No. 4-116-24 of this resource inventory report, and is shown on stream station photo no. 11A and 11B. The station is located at 5,640 ft. elevation. The watershed above the station contains approximately 9,700 acres, has a local relief of 3,200 feet, and is oriented to the west-northwest. Approximately 10 percent of the watershed is forested.

Upper Clark Canyon Station

The Upper Clark Canyon station No. 9 is located in the west central portion of Section 6, Township 10S, Range 9W (Figure 4), approximately 75 yards upstream from confluence of Clark Canyon and unnamed creek entering from the northeast. This location is found on the Red Rock, Montana 7.5

Figure 3. Location of Clark Canyon Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana.

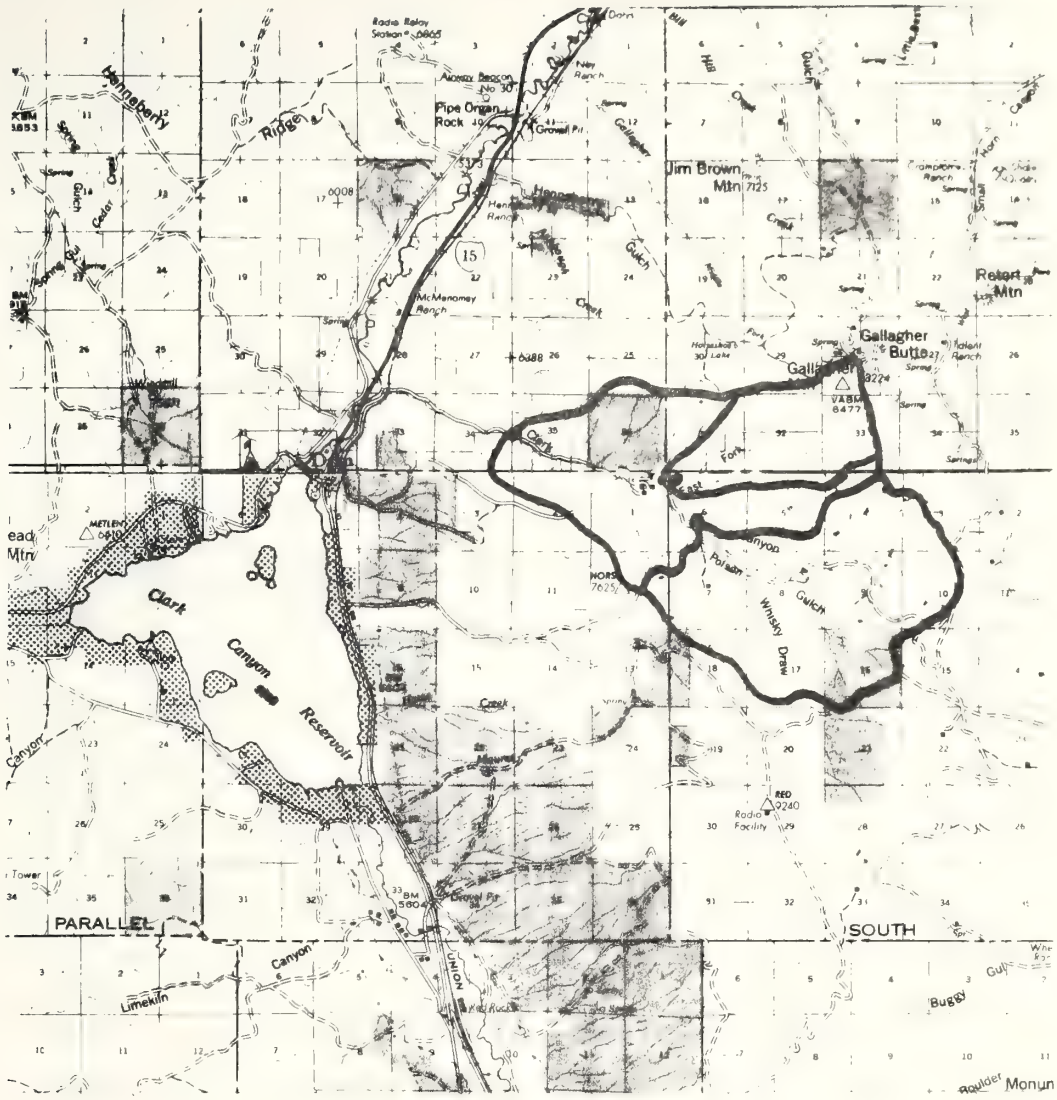

Figure 4. Locations of the Clark Canyon Creek Sampling Stations.

Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 9 on aerial photo No. 4-116-26 of this resource inventory report, and is shown on stream station photo no. 9A. The station is located at 6,320 ft. elevation. The watershed above the station contains approximately 5,400 acres, has a local relief of 2,570 feet, and is oriented to the west-northwest. Approximately 40 percent of the watershed is forested.

East Fork Clark Canyon Station

The East Fork Clark Canyon station No. 10 is located in the north western portion of Section 6, Township 10S, Range 9W (Figure 4), approximately 400 yards upstream from where the road crosses the creek. The original station was located approximately 15 yards above the creek crossing. This location is found on the Red Rock , Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 10 on aerial photo No. 4-116-26 of this resource inventory report, and is shown on stream station photos no. 10A and 10B. The station is located at 6,200 ft. elevation. The watershed above the station contains approximately 1,700 acres, has a local relief of 2,300 feet, and is oriented to the west-southwest. Approximately 20 percent of the watershed is forested.

The East Fork Clark Canyon precipitation station No. 10G is located in northwestern portion of Section 6, Township 10S, Range 9W (Figure 4). The gage is situated on a low knoll approximately 30 yards upstream and to the left of where the road crosses the creek. The site is depicted as site No. 10G on aerial photo No. 4-116-26 of this resource inventory report.

Little Sage Creek Watershed

The Little Sage Creek sample watershed (Figure 5) encompasses approximately 14,700 acres and includes the Little Sage sampling station. This

Figure 5. Location of Little Sage Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana.

low lying southwest oriented basin ranges from approximately 6,400 feet to 8,500 feet elevation. Its broad open valley, surrounding terraces, and low lying hills are primarily composed of Tertiary sediments, but also include some Tertiary volcanics. The basin is almost completely covered by sagebrush-grassland communities. Mollisols are the dominant soil type. The Bureau of Land Management administers over 65 percent of the basin, 25 percent is in scattered private holdings, and less than 10 percent is State land. Basin use is almost exclusively for grazing.

Little Sage Creek Station

The Little Sage station No. 12 is located in the southwestern portion of Section 7, Township 12S, Range 7W (Figure 6), approximately 25 yards upstream from where the road crosses the creek. This location is found on the Rock Island Ranch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 12 on aerial photo No. 14-121-49 of this resource inventory report, and is shown on stream station photos no. 12A and 12B. The station is located at 6,560 ft. elevation. The watershed above the station contains approximately 14,700 acres, has a local relief of 1,950 feet, and is oriented to the southwest. Less than 5 percent of the watershed is forested.

The Little Sage precipitation station No. 12G is located in the southeastern portion of Section 7, Township 12S, Range 7W (Figure 6). The gage is approximately 75 yards north of the road at a point where the sagebrush-grassland boundary coming down the hill from the south meets the road. The site is depicted as site 12G on aerial photo No. 14-121-51 of this resource inventory report.

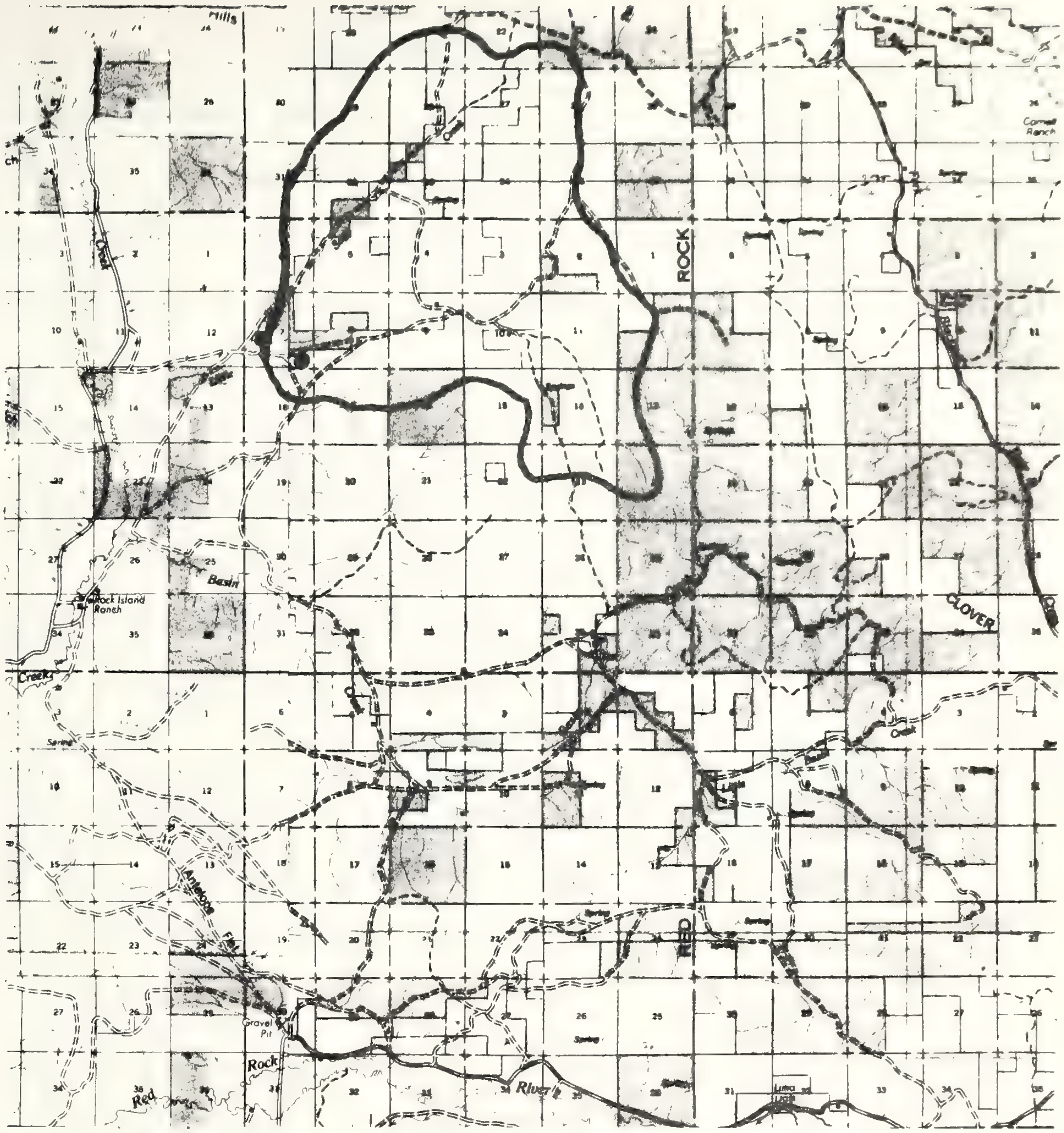

Figure 6. Location of the Little Sage Creek Sampling Station.

Basin Creek Watershed

The Basin Creek sample watershed (Figure 7) contains approximately 33,000 acres, and includes the Lower Basin, Upper Basin, and Little Basin sampling stations. This predominantly broad open watershed is encircled by low hills and faces mainly to the west. Local relief ranges from 6,300 feet to 8,700 feet elevation. The geology of the basin is dominated by Tertiary sediments, although some calcareous sedimentary rocks are found in the southeastern portion of the watershed and Tertiary volcanics appear scattered in the lower watershed. Mollisols dominate throughout the area supporting sagebrush-grassland communities. Nearly 60 percent of the watershed is administered by the Bureau of Land Management, 35 percent is State land, while less than 10 percent is in private holdings. The area is almost entirely used for livestock grazing, although large antelope herds winter in the broad open valley.

Lower Basin Station

The Lower Basin station No. 15 is located in the south central portion of Section 30, Township 12S, Range 7W (Figure 8), approximately 100 yards south of where the road crosses the cattle guard. This location is found on the Rock Island Ranch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 15 on aerial photo No. 12-122-50 of this resource inventory report, and is shown on stream station photos no. 15A and no. 15B. The station is located at 6,420 ft. elevation. The watershed above the station contains approximately 33,000 acres, has a local relief of 2,300 feet, and is oriented to the west. Less than one percent of the watershed is forested.

Figure 7. Location of Basin Creek Sample Basin, Blacktail Planning Unit, Beaverhead County, Montana.

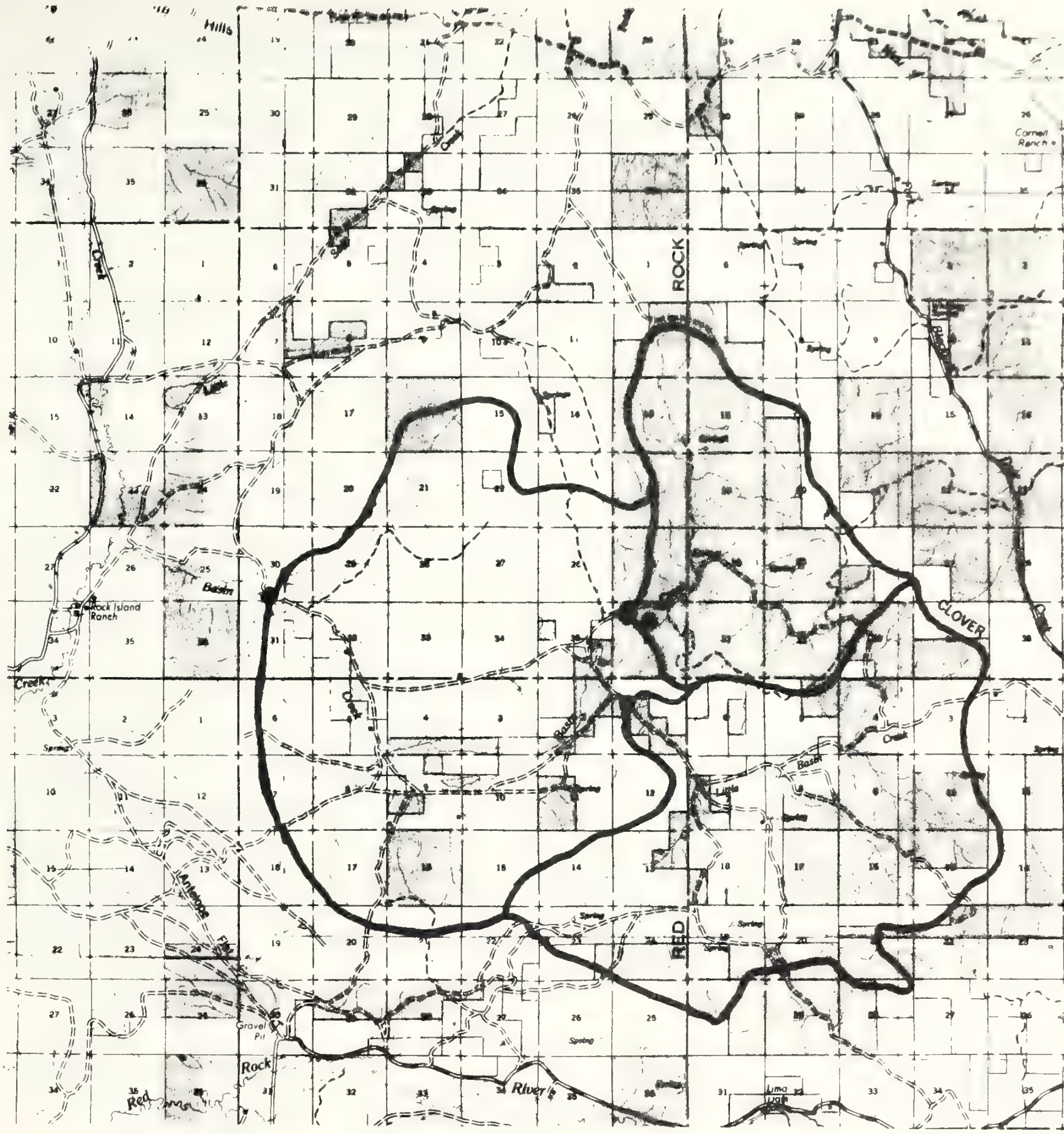

Figure 8. Locations of the Basin Creek Sampling Stations.

Upper Basin Station

The Upper Basin station No. 13 is located in the northwestern portion of Section 36, Township 12S, Range 7W (Figure 8), approximately 450 yards upstream from the section line. This location is found on the Vinegar Hill Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 13 on aerial photo No. 12-122-52 of this resource inventory report, and is shown on stream station photos no. 13A and no. 13B. The station is located at 6,980 ft. elevation. The watershed above the station contains approximately 6,700 acres, has a local relief of 1,400 feet, and is oriented to the southwest. Less than 5 percent of the watershed is forested.

The Upper Basin precipitation station No. 13G is located in the northwestern portion of Section 36, Township 12S, Range 7W (Figure 8). The gage is approximately 75 yards upstream and to the southeast of the stream gaging station No. 13. The site is depicted as site 13G on aerial photo No. 12-122-52 of this resource inventory report.

Little Basin Station

The Little Basin station No. 14 is located in the northwestern portion of Section 1, Township 13S, Range 7W (Figure 8), approximately 15 yards upstream from the bridge where the road crosses the creek. This location is found on the Henry Gulch, Montana 7.5 Series U.S. Geological Survey Topographic Quadrangle. The station is depicted as site No. 14 on aerial photo No. 12-122-52 of this resource inventory report, and is shown on stream station photos no. 14A and 14B. The station is located at 6,860 ft. elevation. The watershed above the station contains approximately 11,800 acres, has a local relief of 1,800 feet, and is oriented to the northwest. Less than one percent of the watershed is forested.

RESULTS AND DISCUSSION

The results of the water quality survey of the Blacktail, Clark Canyon, Little Sage and Basin Creek sample watersheds of the Blacktail Planning Unit are summarized and briefly discussed below. The basin data for each station is found on the Appendix of this volume.

Blacktail Creek

The Blacktail Creek sample basin was visited a total of 13 and 13 times during the two hydrologic years. The watershed is closed by the Montana Department of Fish and Game until mid-May. The upper stations were monitored 13 and 12 times respectively each year.

Channel Stability Ratings

The Lower Blacktail, Upper Blacktail, and Indian Creek stream sections were evaluated on August 15, 1976. The portion of Lower Blacktail Creek between the lower station and the Beaverhead National Forest fence was rated as 'good' (65) (Table 1), approximately a 2.5 mile stream segment above the Forest Service fence was rated as 'fair' (77) (Table 2), and Indian Creek as 'good' (67) (Table 3).

Precipitation

Precipitation was measured at the Upper Blacktail precipitation station from May 12 through November 12, 1977 and from June 4 through September 15, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Lima and Lakeview weather stations (Figure 9). The Blacktail station received heavy spring and early summer precipitation in 1977, although this pattern is not indicated for 1978.

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Table 1

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Blacktail
8/15/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6) 5	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4) 3	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 4	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) 3	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8) 7	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8) 6	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) 10	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		-		65		-		-

Add the values in each column for a total reach score here. (E. - + G. 65 + F. - + P. - = 65).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

USDA-FOREST SERVICE

Table 2

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Blacktail
8/15/76

Item Rated	Stability Indicators by Classes								
	EXCELLENT		GOOD		FAIR		POOR		
I. UPPER BANKS									
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	(8)	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6) 4	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	(8)	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 4	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)	12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	(4)	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	(8)	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) 3	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	(8)	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12) 9	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	(16)	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12) 11	Extensive deposits of predominately fine particles. Accelerated bar development.	(16)	16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	(4)	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	(4)	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	(8)	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	(16)	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	(24)	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4)	4
COLUMN TOTALS →	–		48		29				

Add the values in each column for a total reach score here. (E. – + G. 48 + F. 29 + P. – = 77).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

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Table 3

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Indian Creek
8/15/76

Item Rated	Stability Indicators by Classes								
	EXCELLENT		GOOD		FAIR		POOR		
I. UPPER BANKS									
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +		8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small, Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.		12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.		8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 5	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.		12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained, W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods, W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.		4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6) 5	<20% rock fragments of gravel sizes, 1-3" or less.		8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.		8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) 6	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.		16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8) 6	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.		16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.		4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.		4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 5	No packing evident. Loose assortment, easily moved.		8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8) 7	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.		16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) 10	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.		24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.		4
COLUMN TOTALS →		5		45		13		4	

Add the values in each column for a total reach score here. (E. 5 + G. 45 + F. 13 + P. 4 = 67).

Reach score of: <38=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

R1-2500-5 (6

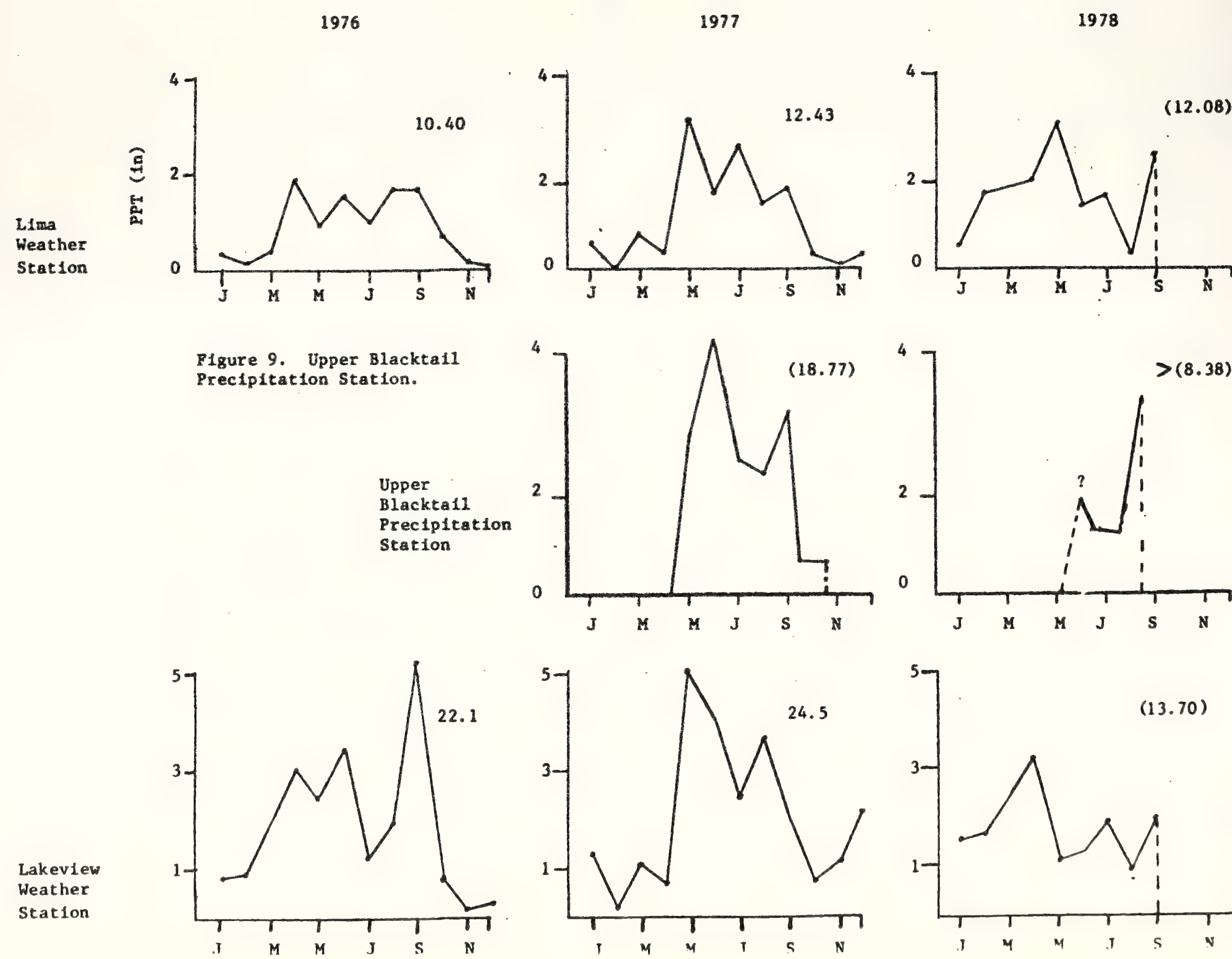


Figure 9. Upper Blacktail Precipitation Station.

Stream Discharge

The staff-discharge rating curves for the Lower Blacktail, Upper Blacktail and Indian sampling stations are presented in Figures 10-12. The Blacktail Creek gauging sites remained nearly stable during the two sampling years. The Indian station, however, experienced both sedimentation and modest bank erosion during peak flow periods.

The 1977 and 1978 annual hydrographs for the Lower Blacktail, Upper Blacktail and Indian Creek sampling stations are presented in Figures 13-18. Peak flow during 1977 at the Lower Blacktail station apparently occurred in late June with an estimated crest stage value of 220 cfs. The lowest recorded flow during 1977 was only 18 cfs during late September. The 1978 year produced slightly earlier, but greater peak flow estimated at 430 cfs in early June. The lowest recorded flow for 1978 hydrologic year was 12 cfs during the Fall of 1977. The Upper Blacktail station exhibited similar patterns. An estimated peak discharge of 167 cfs occurred in early June, 1977, however, the lowest recorded flow for the year was 13 cfs in November, 1976. The annual peak flow in 1978 was estimated at 275 in mid-June, while the lowest flow was again recorded at 13 cfs for the previous November. Peak discharge for Indian reek occurred in early June during both hydrologic years, with estimated crest stage values of 5.2 cfs and 7.1 cfs respectively. The low flow period occurred from September - November 1977, when discharge was less than 0.20 cfs. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.

The respective annual hydrograph data was used to estimate the annual water yields for each station (Table 4). An estimated 22,700 acre feet and 30,200 acre feet passed the Lower Blacktail discharge sub-station

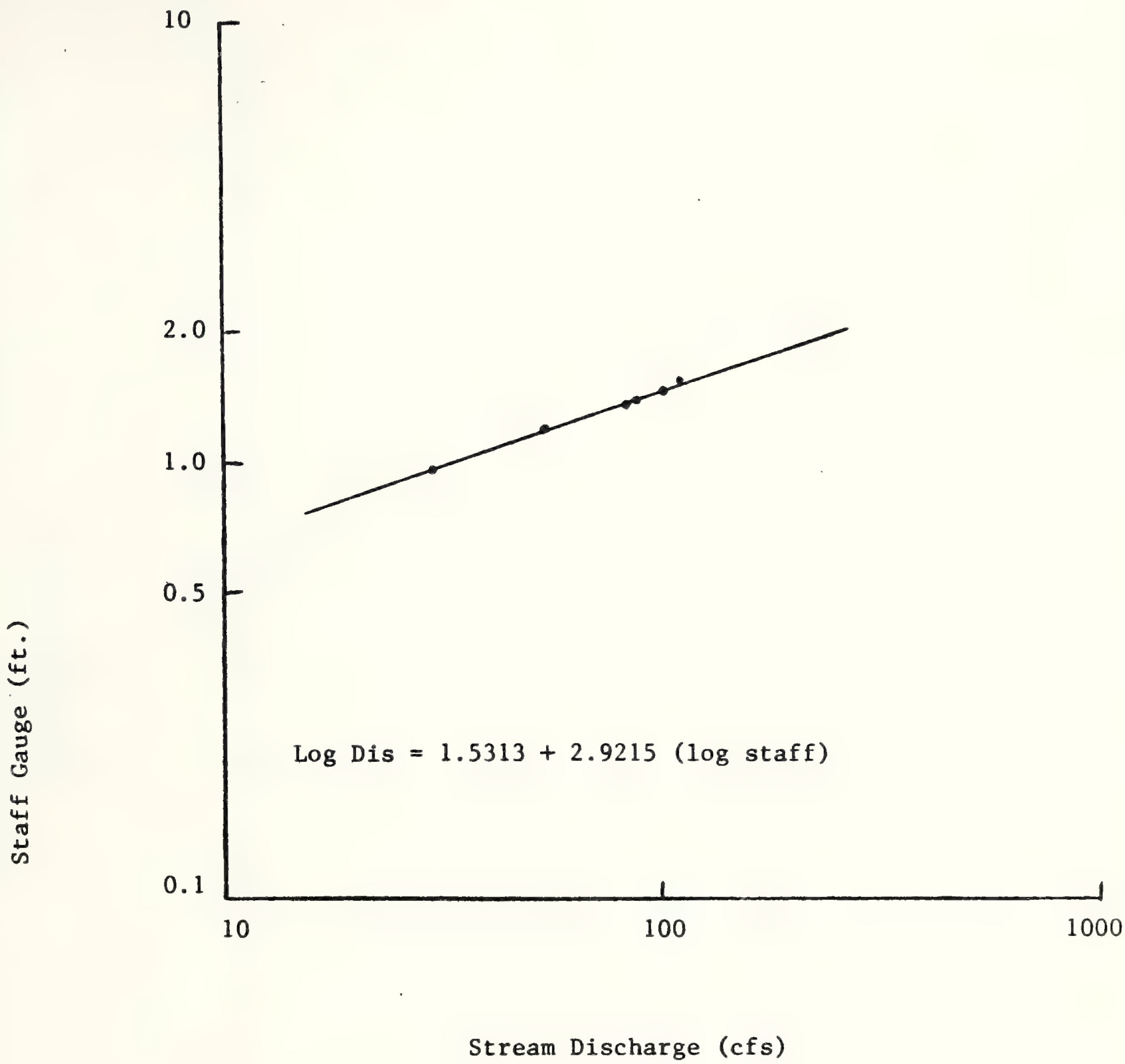


Figure 10. Staff-discharge Rating Curve for Lower Blacktail Sampling Station.

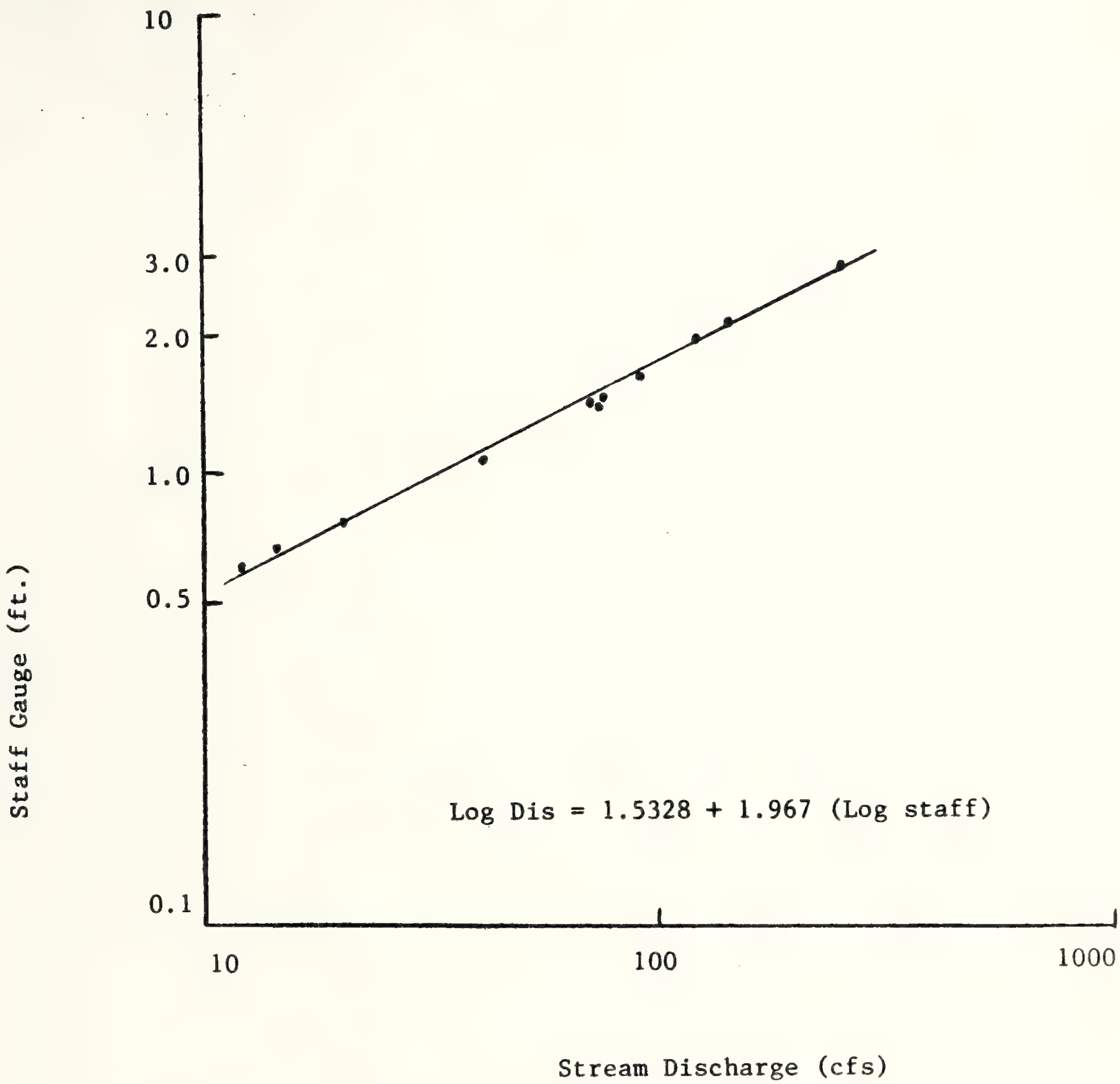


Figure 11. Staff-discharge Rating Curve for Upper Blacktail Sampling Station.

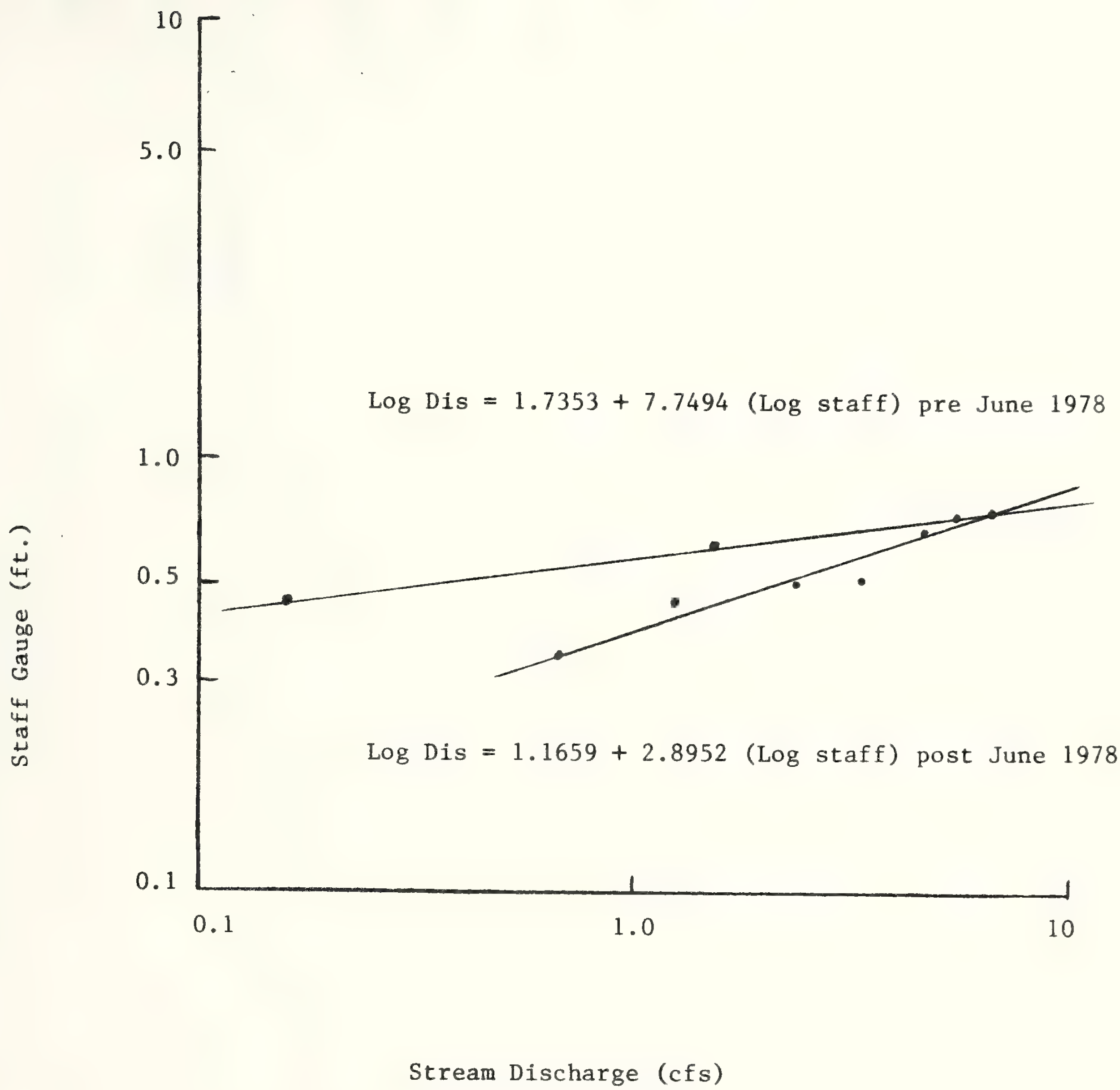


Figure 12. Staff-discharge Rating Curve for Indian Sampling Station.

FIGURE 13. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER BLACKTAIL - 1977

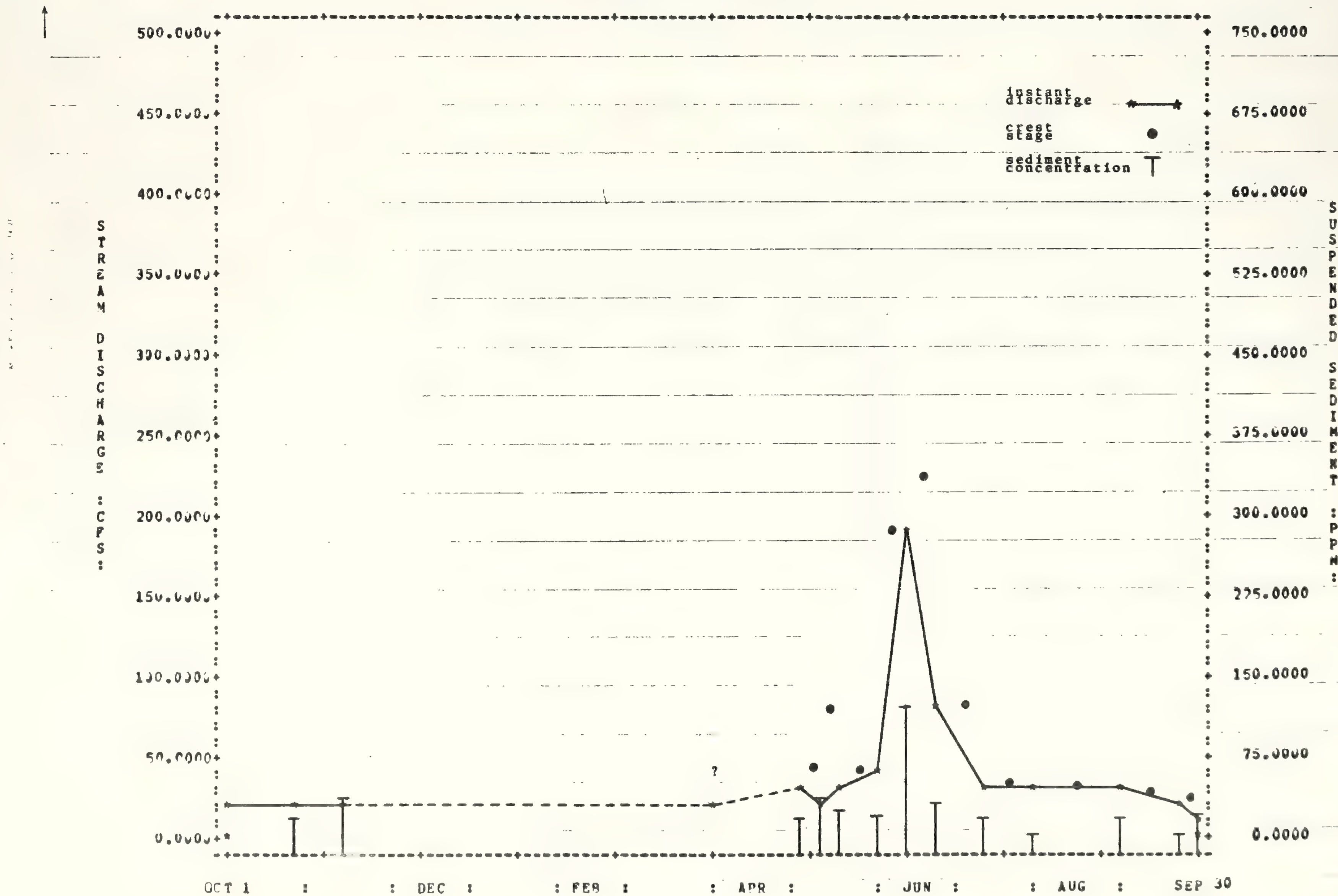


FIGURE 14. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER BLACKTAIL - 1978

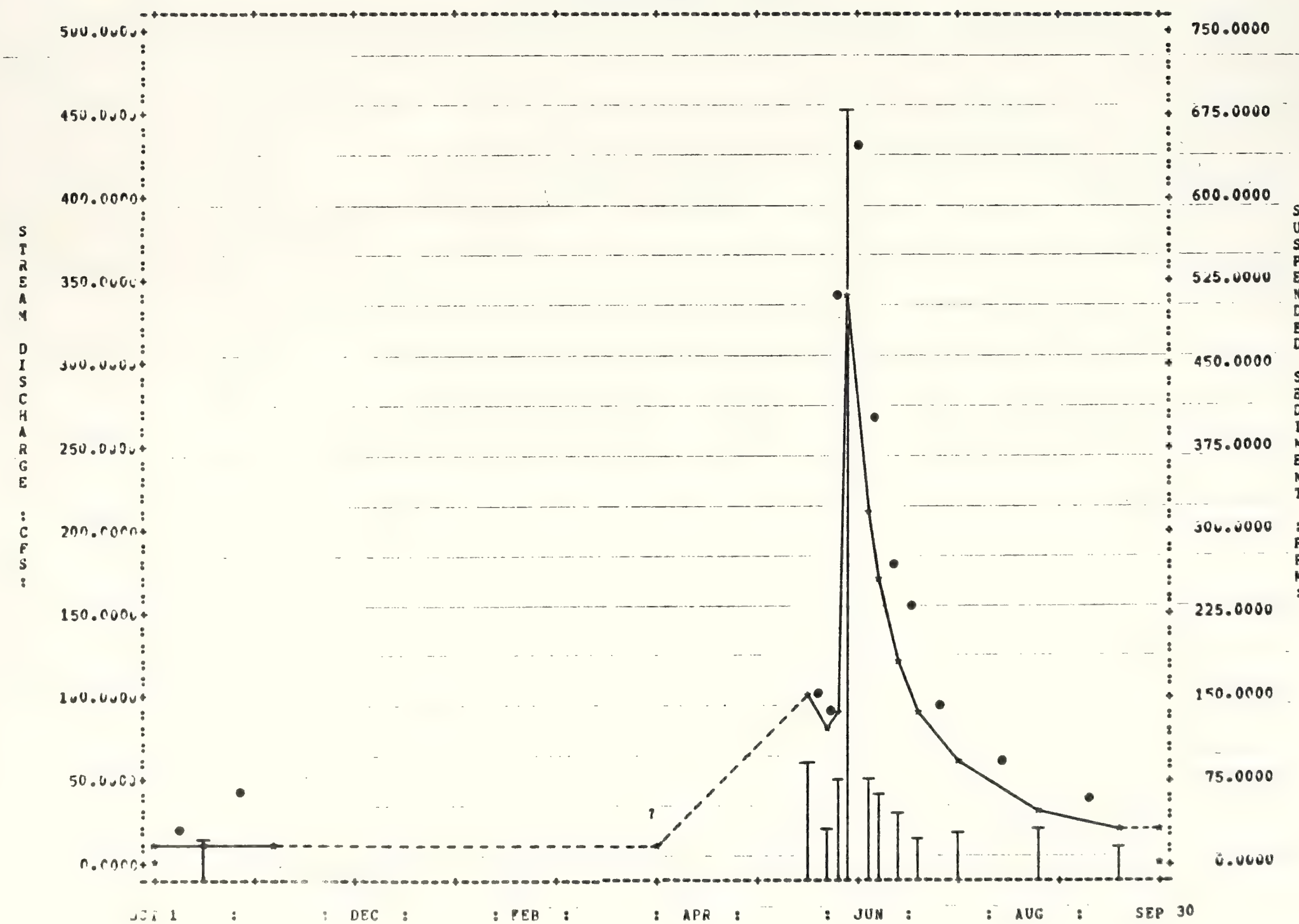


FIGURE 15. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER BLACKTAIL - 1977

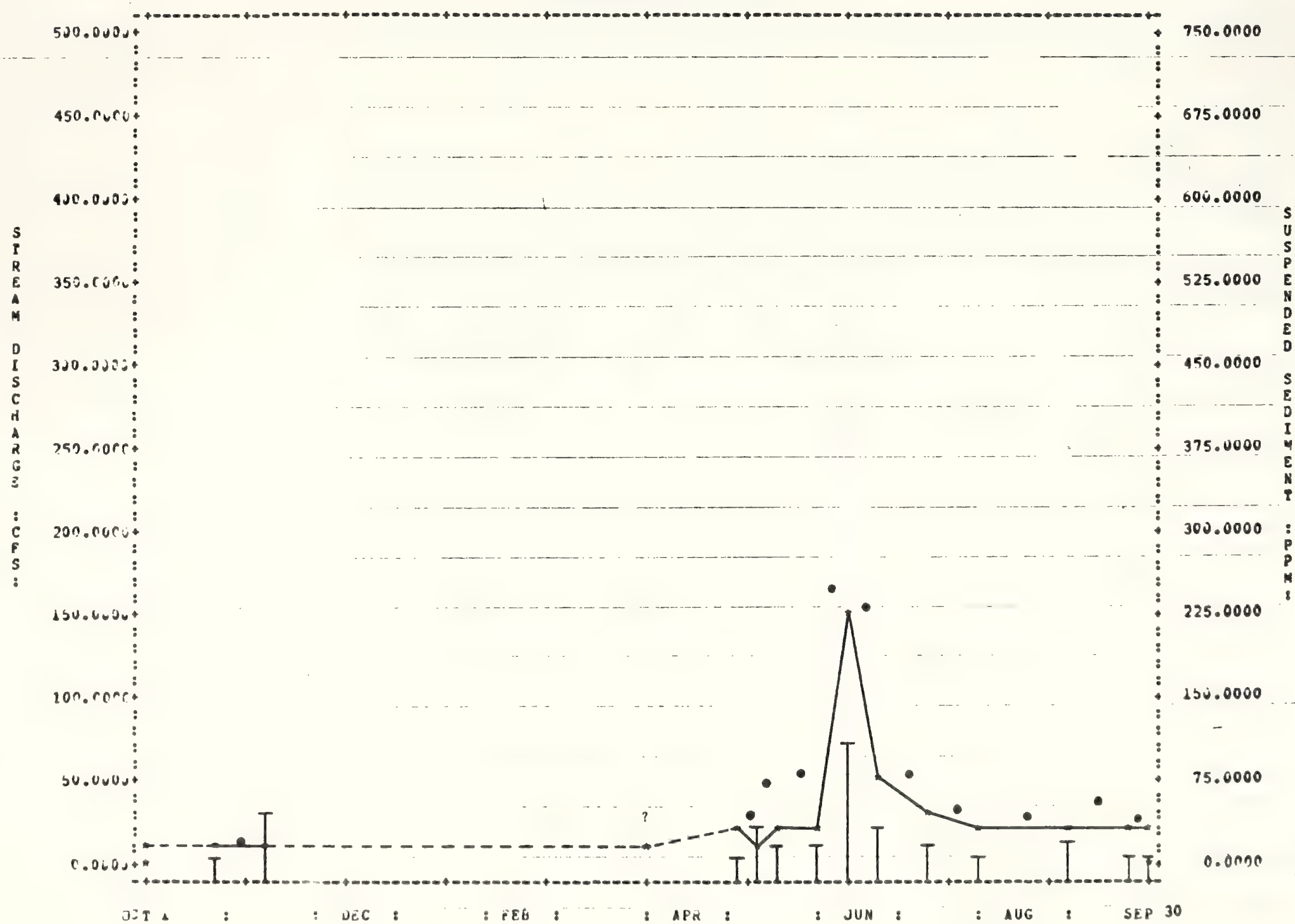


FIGURE 16. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER BLACKTAIL - 1978

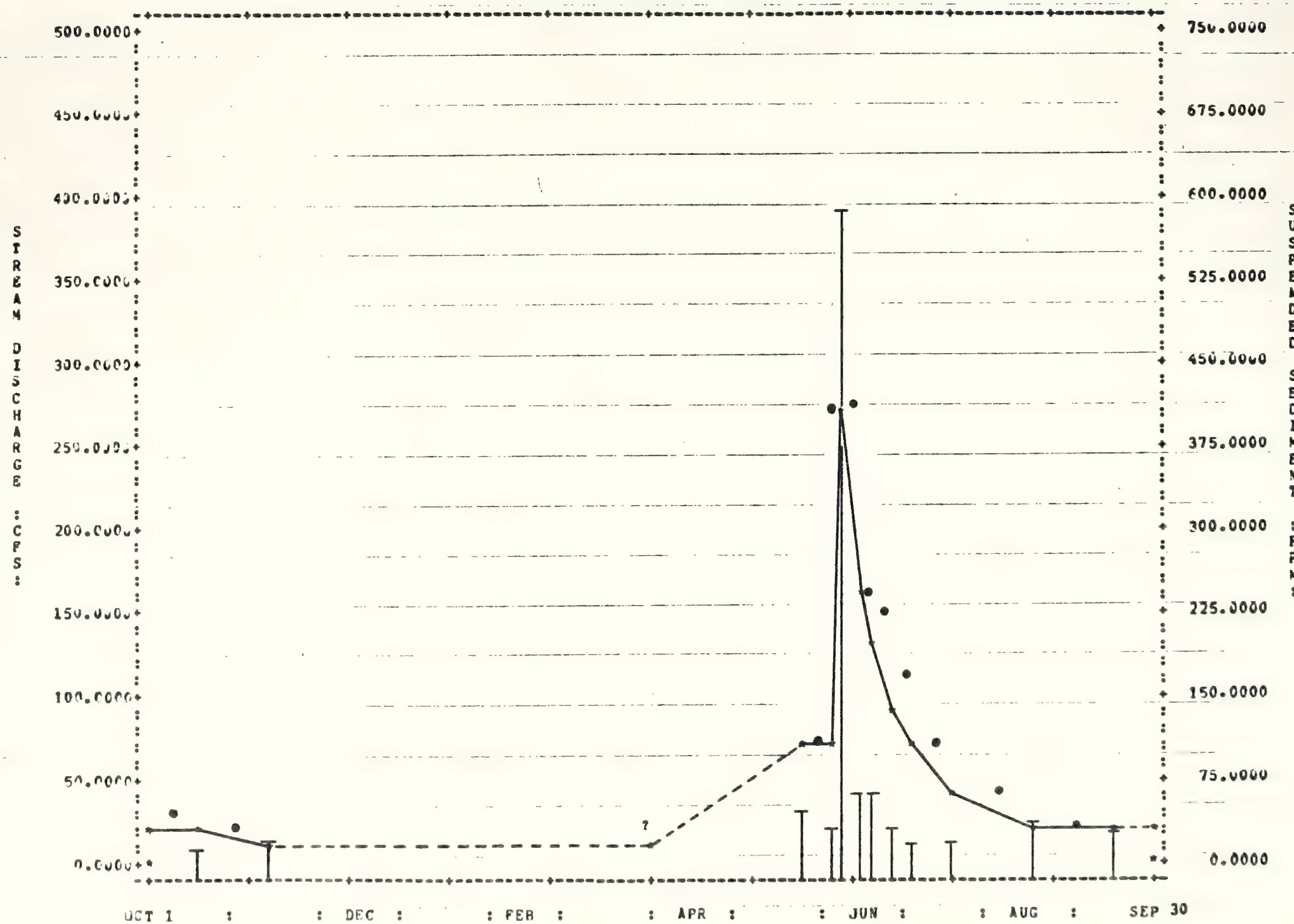


FIGURE 17. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

INDIAN - 1977

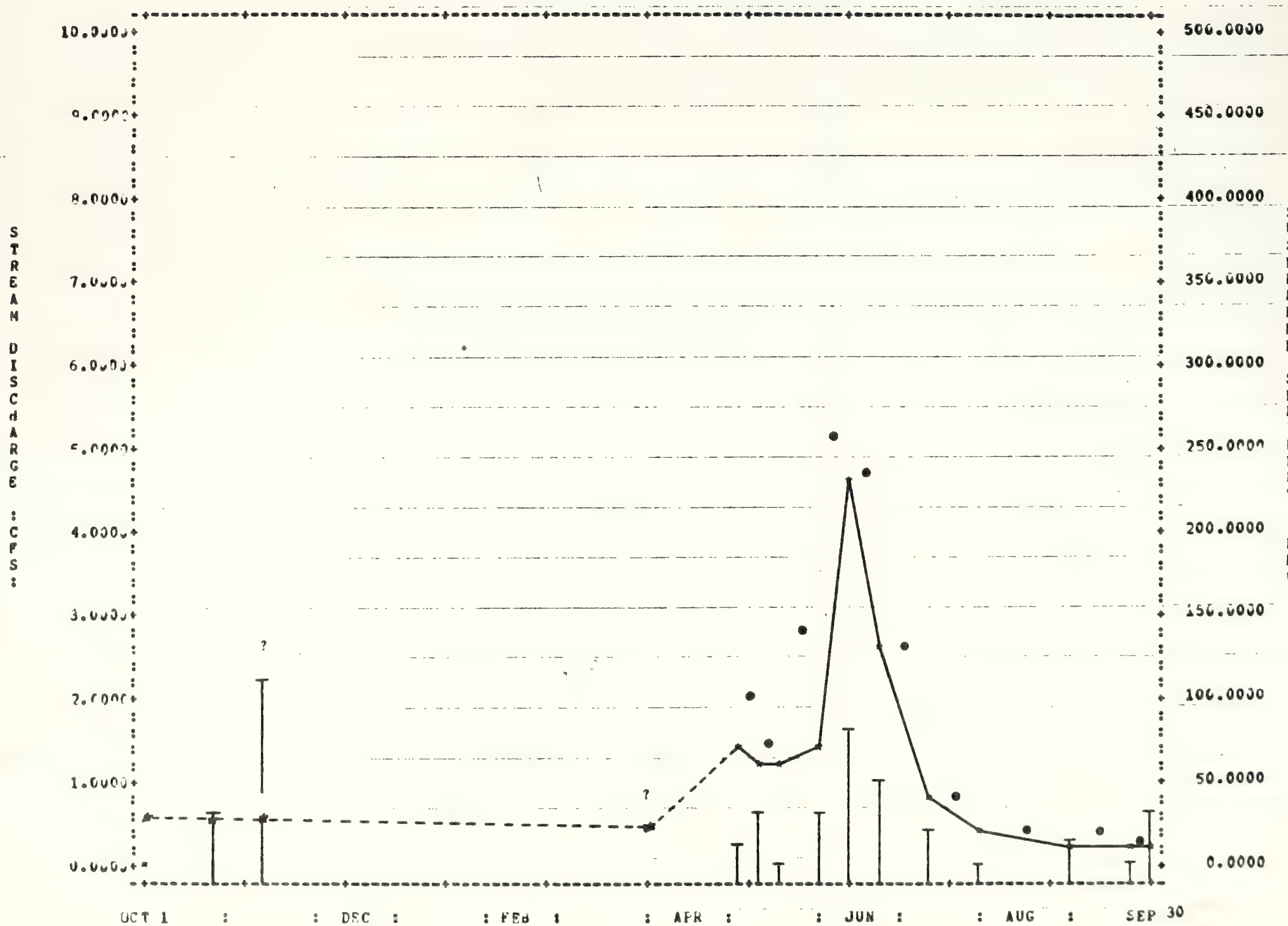


FIGURE 18. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

INDIAN - 1978

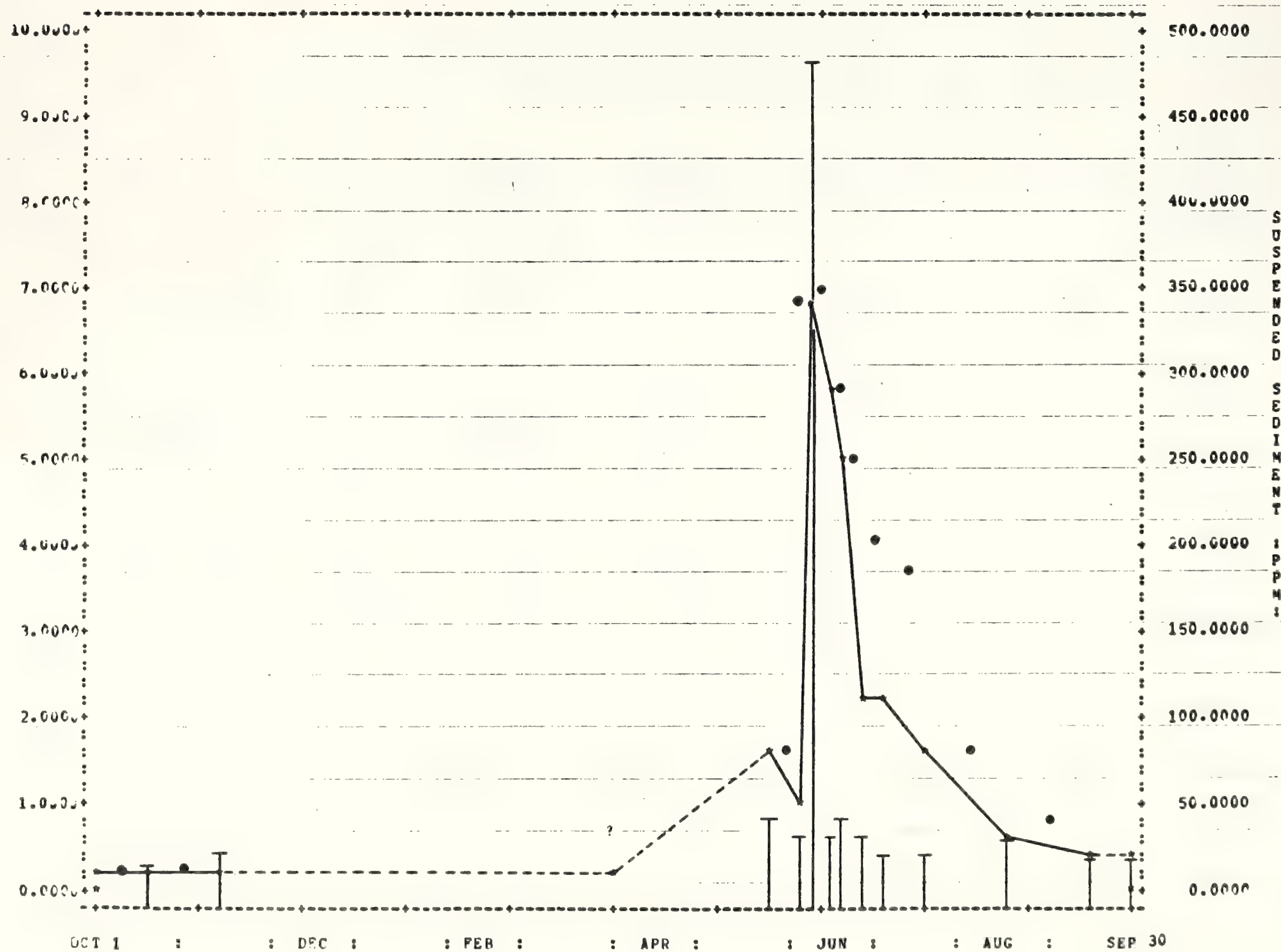


Table 4 Estimated Water and Sediment Yields for the Blacktail Sample Basin, 1977-1978.

Station Name	Water Year	Estimated Water Yield (ac. - ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in. / ac.)	Sediment Yield (lbs/acre)
Lower Blacktail Station(s)	1977	22,700	1,180	29,150 18,560	9.34	127
	1978	30,200	5,360	29,150 18,560	12.4	578
Upper Blacktail Station	1977	16,100	820	13,890	13.9	118
	1978	24,200	3,430	13,890	20.9	493
Indian Station	1977	560	31	1,090	6.21	56.3
	1978	610	75	1,090	6.68	137

during 1977 and 1978. The Upper Blacktail averaged approximately 75 percent of the lower station's yields. Indian Creek generated annual yields of 560 and 610 acre feet respectively. Each station indicated greater discharges during 1978, although differences for Indian Creek may be underestimated owing to channel changes at the station site.

Suspended Sediment

The annual pattern of sediment concentration for each station by hydrologic year is depicted in Figures 13-18. Suspended sediment concentrations at the Lower Blacktail water quality sub-station ranged from <5 ppm at low flow to 670 ppm at high flow, those for the Upper station ranged from <5 ppm to 585 ppm, and from <5 ppm to 480 ppm for the Indian station. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for the Blacktail and Indian stations were statistically significant, and are presented in Figures 19-21. The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the sample stations were estimated from respective water yield and sediment concentration data (Table 4). Sediment yield data for the Lower Blacktail station were generated from suspended sediment concentration data obtained at the water quality sub-station No. 8A, but using water yield data from the discharge monitoring sub-station No. 8B. The Lower and Upper stations produced approximately 1,180 tons and 820 tons of suspended sediment respectively during 1977. These yields increased to 5,360 tons and 3,430 tons for the more active 1978 hydrologic year. Sediment

FIGURE 19. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER BLACKTAIL

Log Sed = 0.876(Log Dis) - 0.0361

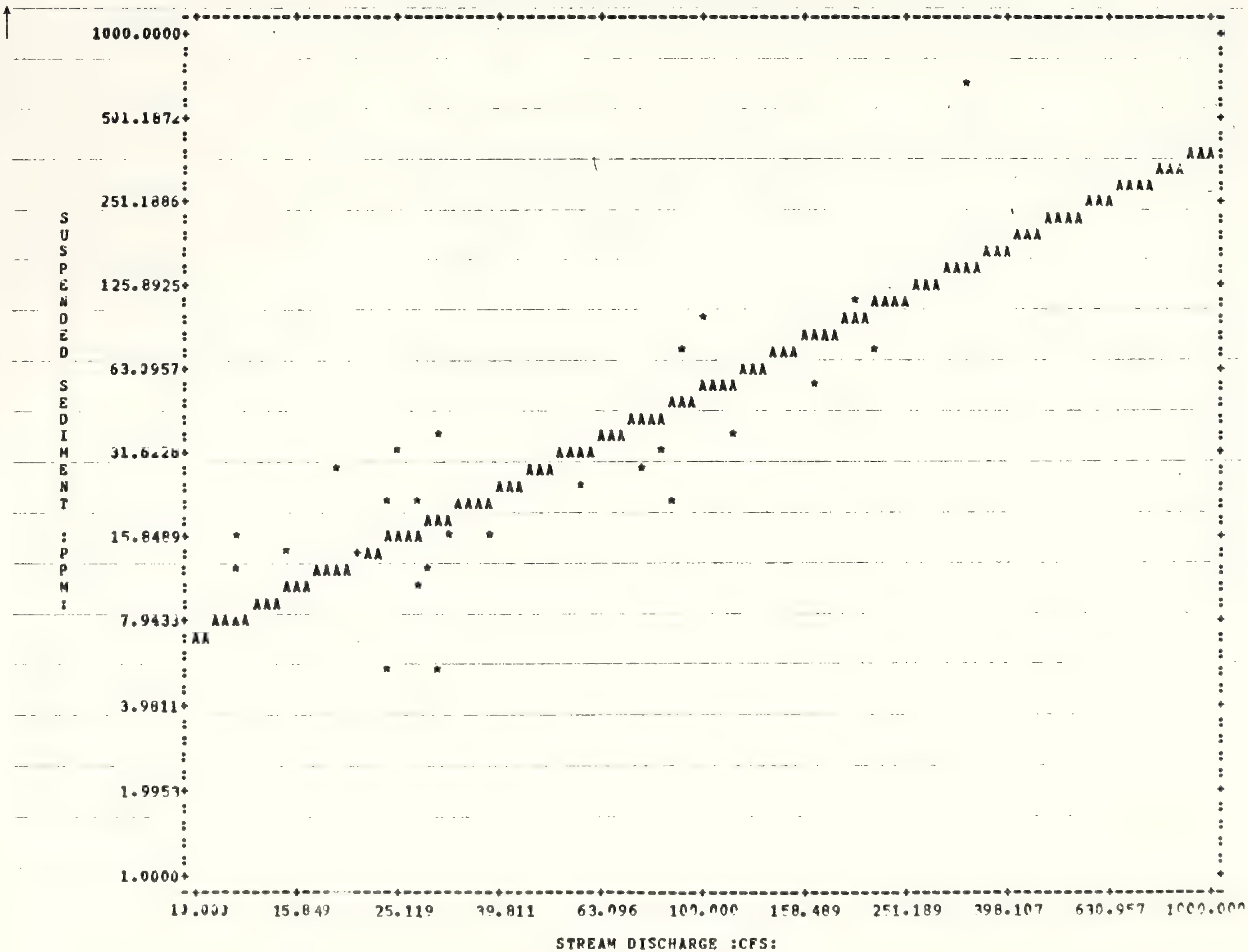


FIGURE 20. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER BLACKTAIL

LOG SED = 0.9088(LOG DIS) - 0.0812

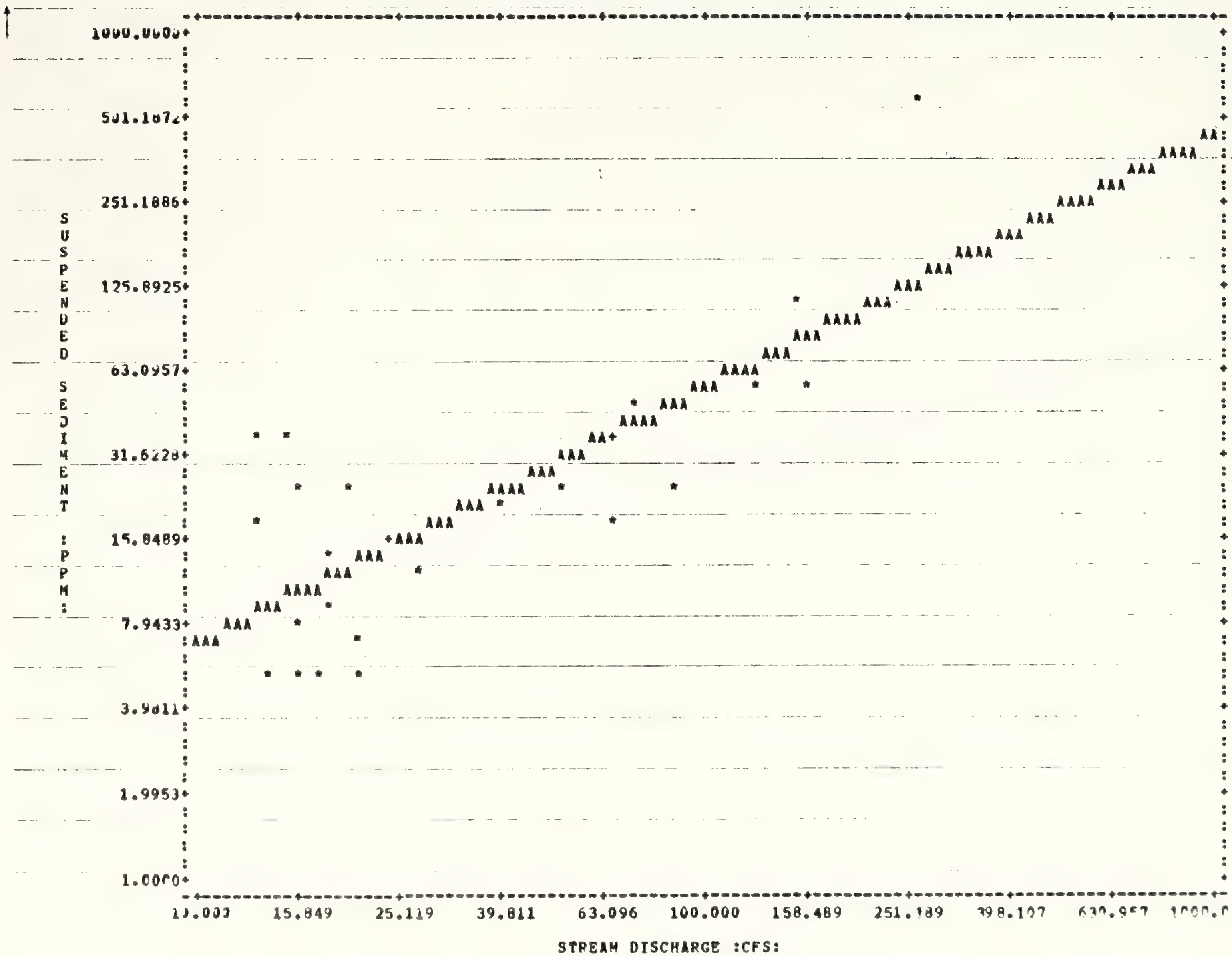
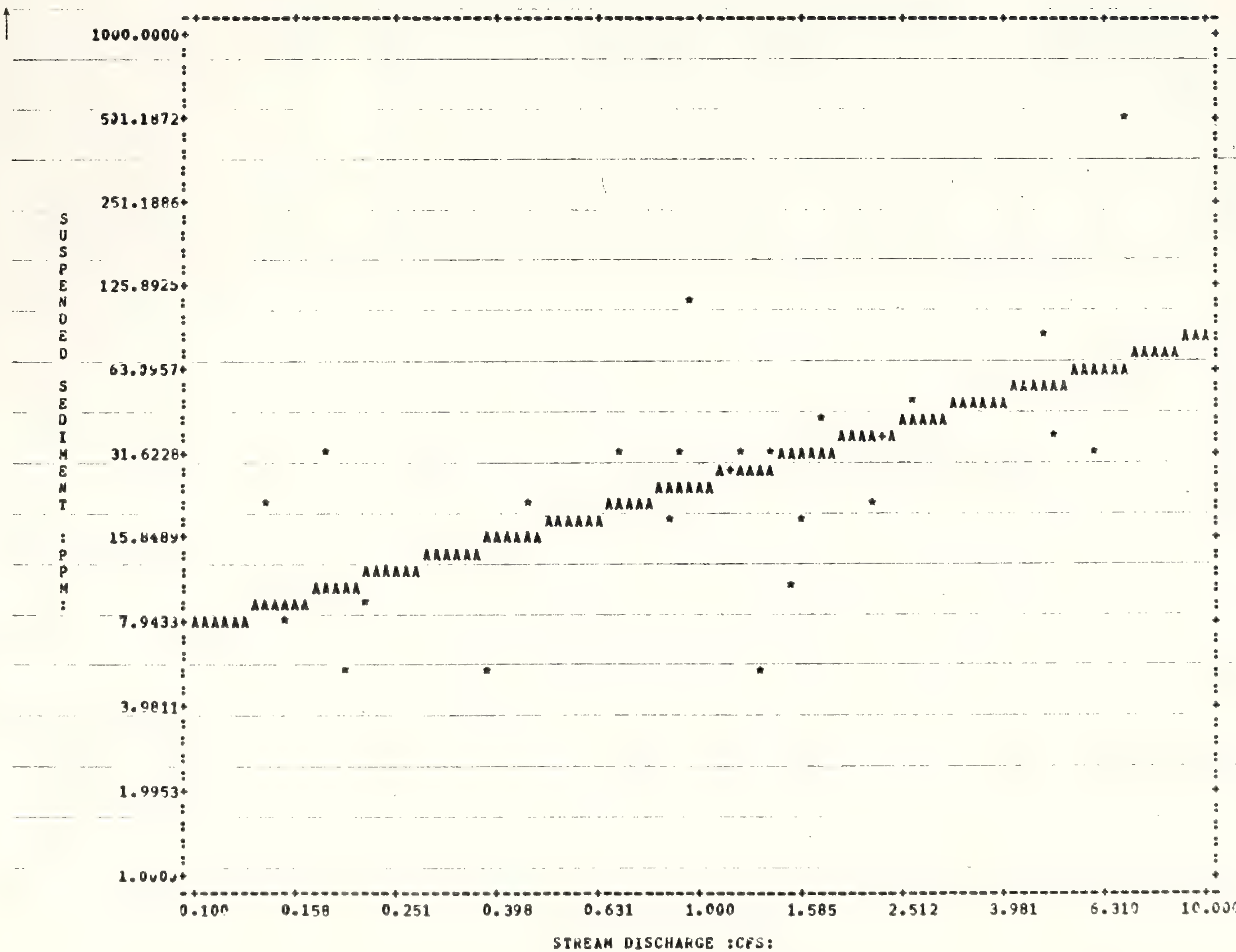


FIGURE 21. SUSPENDED SEDIMENT VS STREAM DISCHARGE - INDIAN

LOG SED = 1.3929 + 0.5179(LOG DIS)



yields for the Indian station were 31 tons and 75 tons.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentration occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et. al., 1977,pp. 74-76).

Specific conductance for the Lower Blacktail station ranged from a low of 208 µmhos during high spring runoff to a high of 363 µmhos during late summer base flow. The Upper Blacktail station exhibited a similar pattern, values ranging from 190 µmhos to a high of 357 µmhos. Indian Creek experienced greater range in conductivity including values from 282 to 462 umhos. The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 22-24. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 5.

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and

FIGURE 22. CONDUCTIVITY VS STREAM DISCHARGE - LOWER BLACKTAIL

LOG COND = 2.6453 - 0.0938(LOG DIS)

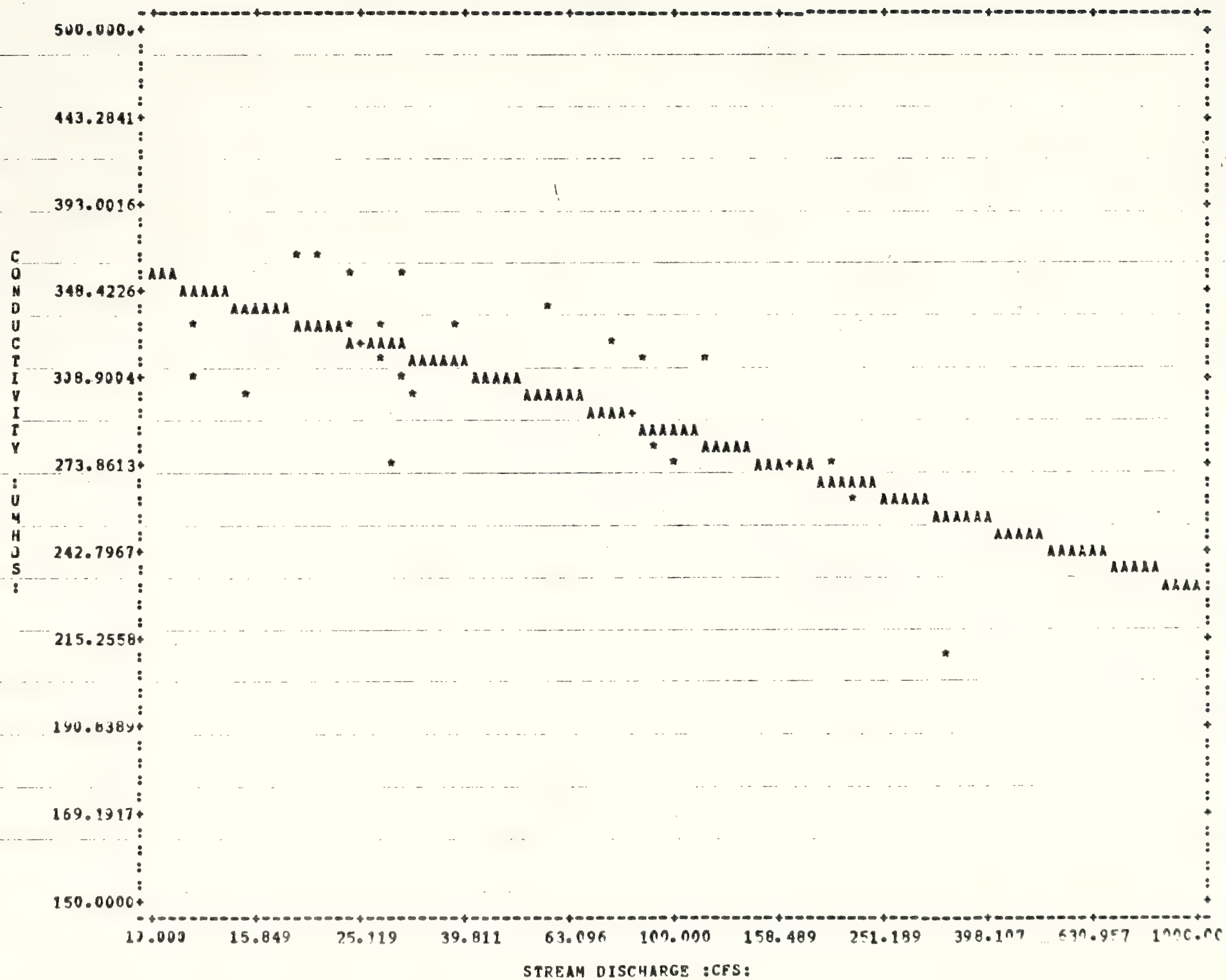


FIGURE 23. CONDUCTIVITY VS STREAM DISCHARGE - UPPER BLACKTAIL

LOG COND = 2.6632 - 0.1233(LOG DIS)

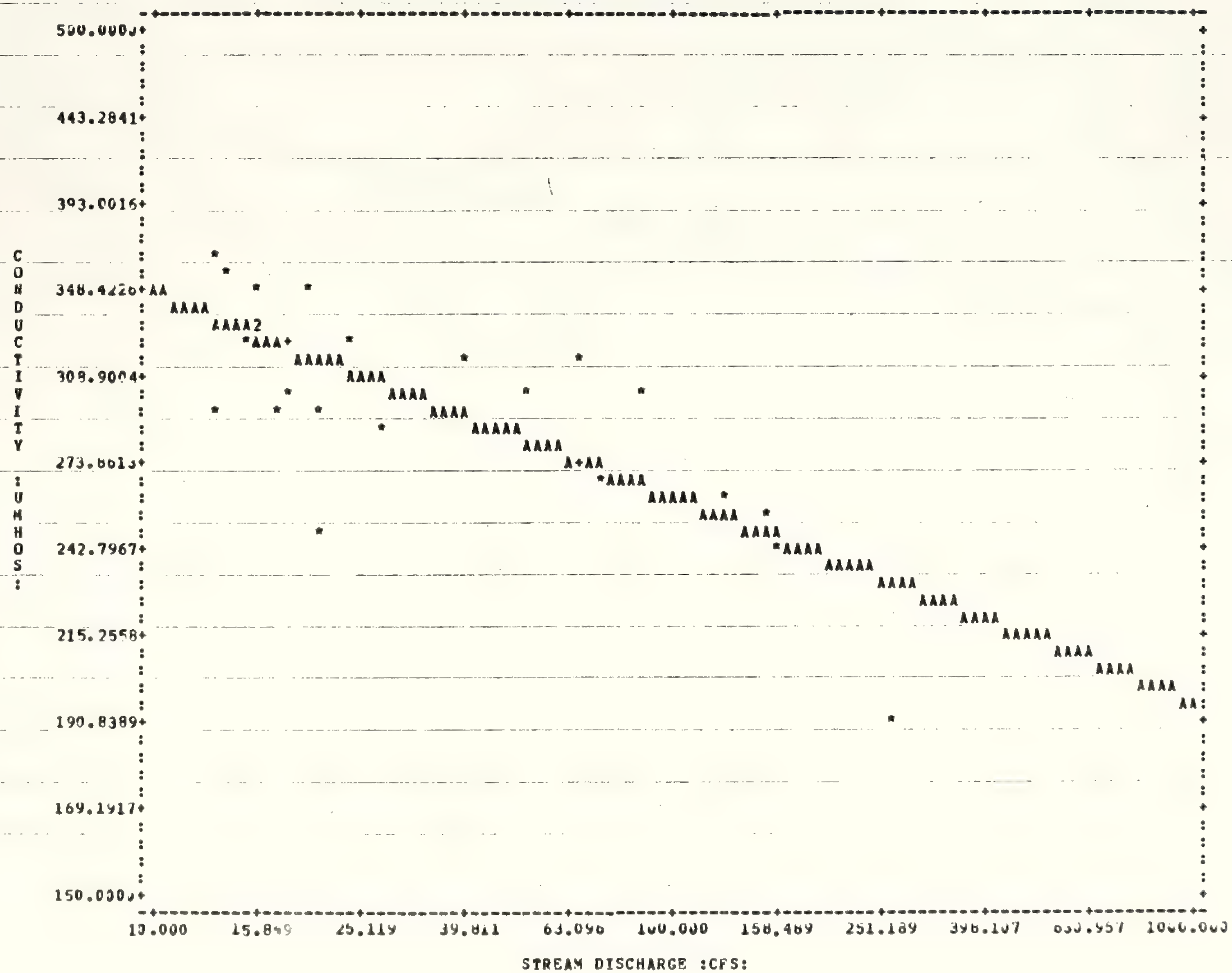


FIGURE 24. CONDUCTIVITY VS STREAM DISCHARGE - INDIAN

LOG COND = 2.5791 - 0.0569(LOG DIS)

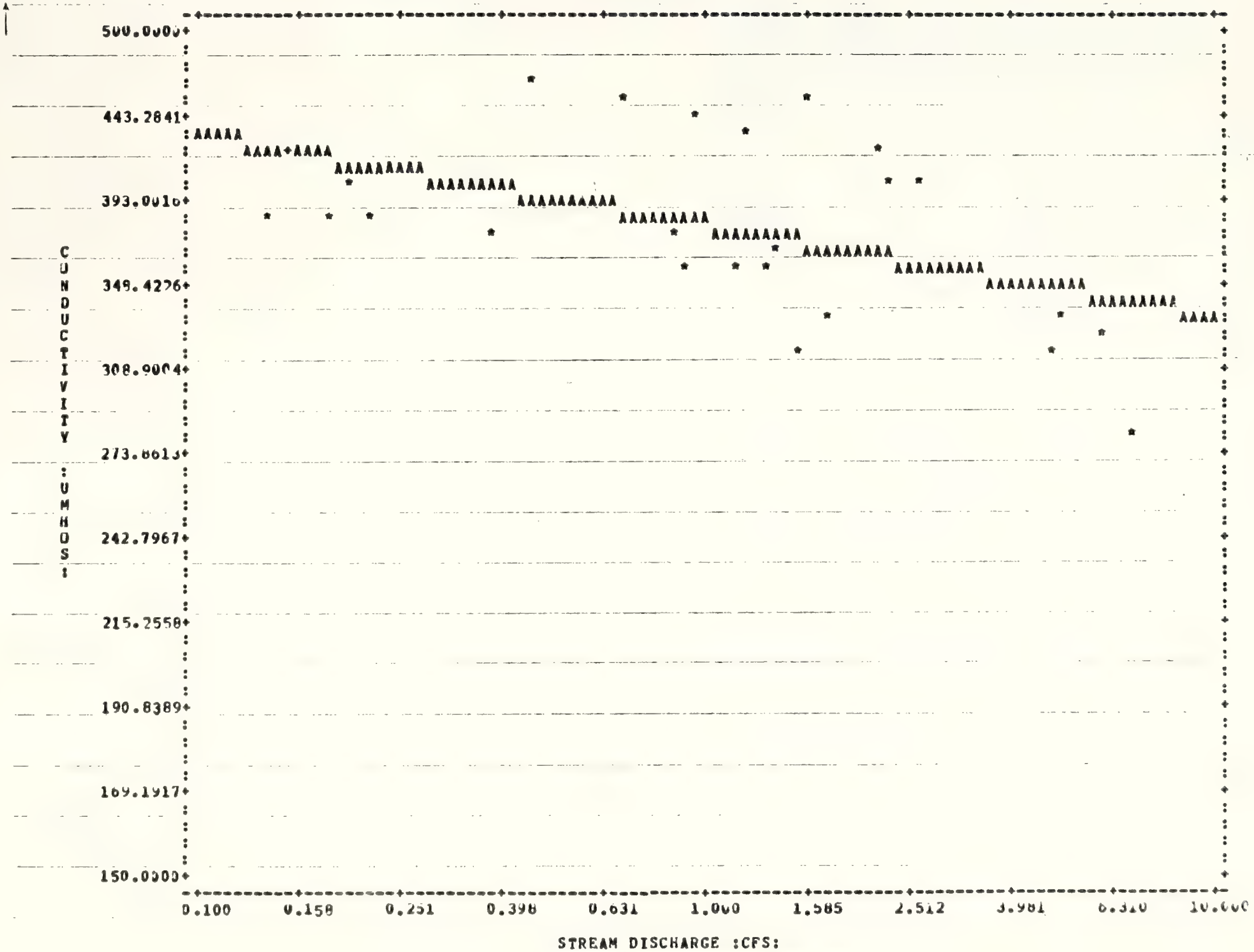


Table 5 Hydrochemical Characteristics of the Blacktail Watershed Sampling Stations, 1977-1978.

	Lower Blacktail	Upper Blacktail	Indian
pH	7.95 - 8.28	7.76 - 8.23	7.95 - 8.30
Alkalinity ($CaCO_3$) (mg/1)	130 - 165	121 - 178	142 - 178
Specific Conductance (μmhos)	208 - 363	190 - 357	282 - 462
Total Dissolved Solids (mg/1)	135 - 235	124 - 232	183 - 300
Ca (mg/1)	41 - 56	39 - 55	52 - 76
Mg (mg/1)	9.7 - 16	7.8 - 15	8.5 - 15
Na (mg/1)	3.0 - 4.8	2.7 - 5.0	1.3 - 2.6
K (mg/1)	0.72 - 1.3	0.70 - 1.1	.60 - 1.0
HCO_3 (mg/1)	159 - 202	148 - 218	174 - 217
SO_4 (mg/1)	5 - 28	4 - 26	14 - 69
NH_4 (mg/1)	$<$.01 - .14	$<$.01 - (.44)	$<$.01 - .13
$NO_2 + NO_3 - N$ (mg/1)	$<$.01 - .17	.02 - .15	.02 - .31
PO_4 (Ortho) -P (mg/1)	T - .055	.002 - .048	T - .077

Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Blacktail basin sampling stations for the study period are presented in Table 6. Higher values occurred during the grazing season, especially during 1977 when there were higher livestock concentrations. Maximum fecal coliform levels were 50, 4, and 23 colonies/100 mls respectively for each station. None of the sample coliform counts exceeded the 200 colony/ 100 ml limit of the Montana Water Quality Criteria. The lowest values were associated with the spring and fall seasons.

Comments

The Blacktail Creek basin sustains a high spring discharge owing to its mountainous upland watershed. High water yields contribute to naturally high sediment yields. Cattle use was moderate during the study period. Because of the limited number of samples and the nature of the hydrochemical parameters selected for evaluation, relationships between the water quality characteristics of Blacktail and Indian creeks and the Montana Water Quality Criteria cannot be addressed.

Table 6 Fecal Coliform Counts (colonies/100 mls) for the Blacktail Watershed Sampling Stations, 1977 - 1978.

	Lower Blacktail		Upper Blacktail		Indian	
	1977	1978	1977	1978	1977	1978
April						
May	< 1	2	< 1	< 1	< 2	< 1
June	1	< 2	1	3	< 1	< 1
July	51*	< 1	3	3	< 1*	< 1
August	40*	27*	2	< 1*	23*	2*
September	8	3*	4	1*	< 2	4*
October	4		< 4		< 2	
November	2		1		< 2	

* Stock visually present

(?) Stock presence uncertain

Clark Canyon Creek Basin

The Clark Canyon Creek sample basin was visited a total of 16 and 18 times during the two hydrologic years. The Upper Clark Canyon and East Fork stations were monitored 15 and 18 times respectively. Sampling problems were confined to the East Fork where residual ice, flash flooding, channel alteration, and irrigation diversion were intermittently common. The East Fork station was moved after the 1977 hydrologic year, but channel instability again precluded generating a valid staff-discharge rating curve. Instant discharge readings are primarily those directly taken in the field. No crest stage readings were obtained. Flash flooding often left the thermometer housing perched out of the water.

Channel Stability Ratings

The Lower Clark Canyon, Upper Clark Canyon, and East Fork Clark Canyon stream segments were evaluated on August 13, 1976. The portion of Clark Canyon Creek from the Lower station to the confluence with the East Fork was rated as 'fair' (99) Table 7). The Upper Clark Canyon segment extended upstream from the East Fork for approximately 2 1/2 miles and was rated as 'fair' (109) (Table 8). The East Fork Clark Canyon was ranked 'fair' with a score of (97) (Table 9). The latter rating may be currently underestimated.

Precipitation

Precipitation was measured at the East Fork Clark Canyon precipitation station from April 21 through November 10, 1977 and from April 5 to September 13, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 25). Precipitation peaks are shown for May and September of each

Table 7

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Clark Canyon
8/13/76

Item Rated	Stability Indicators by Classes: EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(3)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9) 8	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6) 5	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9) 8	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6) 5	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16 13
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 5	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12) 10	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) 15	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		—		9		77		13

Add the values in each column for a total reach score here. (E. — + G. 9 + F. 77 + P. 13 = 99).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

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Table 8

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Clark Canyon
8/13/76

Item Rated	Stability Indicators by Classes: EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9) 7	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6) 5	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	9	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16 13
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16 14
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24 19
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →	–		14		45		50	

Add the values in each column for a total reach score here. (E. – + G. 14 + F. 45 + P. 50 = 109).

Reach score of: <38=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

R1-2500-5 (6

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Table 9

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

East Fork Clark Canyon
8/13/76

Item Rated	Stability Indicators by Classes: EXCELLENT		GOOD		FAIR		POOR		
I. UPPER BANKS									
Landform Slope	Bank slope gradient <30%	(2) 2	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	(8)	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6) 5	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	(12)	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6) 5	Moderate to heavy amounts, predominantly larger sizes.	(8)	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9) 9	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	(12)	12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2) 2	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	(4)	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4) 4	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	(8)	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) 3	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	(8)	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12) 12	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	(16)	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12) 10	Extensive deposits of predominately fine particles. Accelerated bar development.	(16)	16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3) 3	Well rounded in all dimensions, surfaces smooth.	(4)	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	(4) 4	
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 6	No packing evident. Loose assortment, easily moved.	(8)	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12) 12	Marked distribution change. Stable materials 0-20%.	(16)	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) 16	More than 50% of the bottom in a state of flux or change nearly yearlong.	(24)	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	(4) 4	
COLUMN TOTALS →		2		14		73		8	

Add the values in each column for a total reach score here. (E. 2 + G. 14 + F. 73 + P. 8 = 97).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

year, the latter peak being reduced each year as the rain gauge had been disturbed. Precipation values for the East Fork precipitation station apparently exceed those of either of the weather stations

Stream Discharge

The staff-discharge rating curves for the Lower Clark Canyon and Upper Clark Canyon sampling stations are presented in Figures 26 and 27. The channel section at the upper station remained relatively stable throughout the sampling period, but the lower station experienced moderate channel erosion near the staff. A staff-discharge rating curve was not generated for the East Fork station owing to severe channel instability.

The 1977 and 1978 annual hydrographs for the Clark Canyon Creek sampling stations are presented in Figures 28-32. A hydrograph for the East Fork for 1977 is not included because of the erratic discharge values caused by channel instability, flash flooding, and irrigation diversion. Peak flow during 1977 at the Lower Clark Canyon station apparently occurred in early to mid-April. An estimated crest stage value of 5.2 cfs in mid-April may have been superseded by a higher value during an unusually warm period in early April. Lowest flows were recorded in August and September at 0.26 cfs. An estimated peak flow in excess of 9.4 cfs occurred during mid-May, 1978, which was preceeded by an annual low flow of 0.12 cfs in mid-April. The erratic discharge patterns at this station are primarily attributed to the widespread irrigation diversion of stream water between the East Fork and Lower Clark Canyon stations. An early peak flow of 14 cfs occurred at the Upper Clark Canyon station in 1977, however, this value may be overestimated owing to residual ice conditions in the sampling reach. A later peak flow of 8.7 cfs was noted for mid-June. Lowest recorded flow for the year was

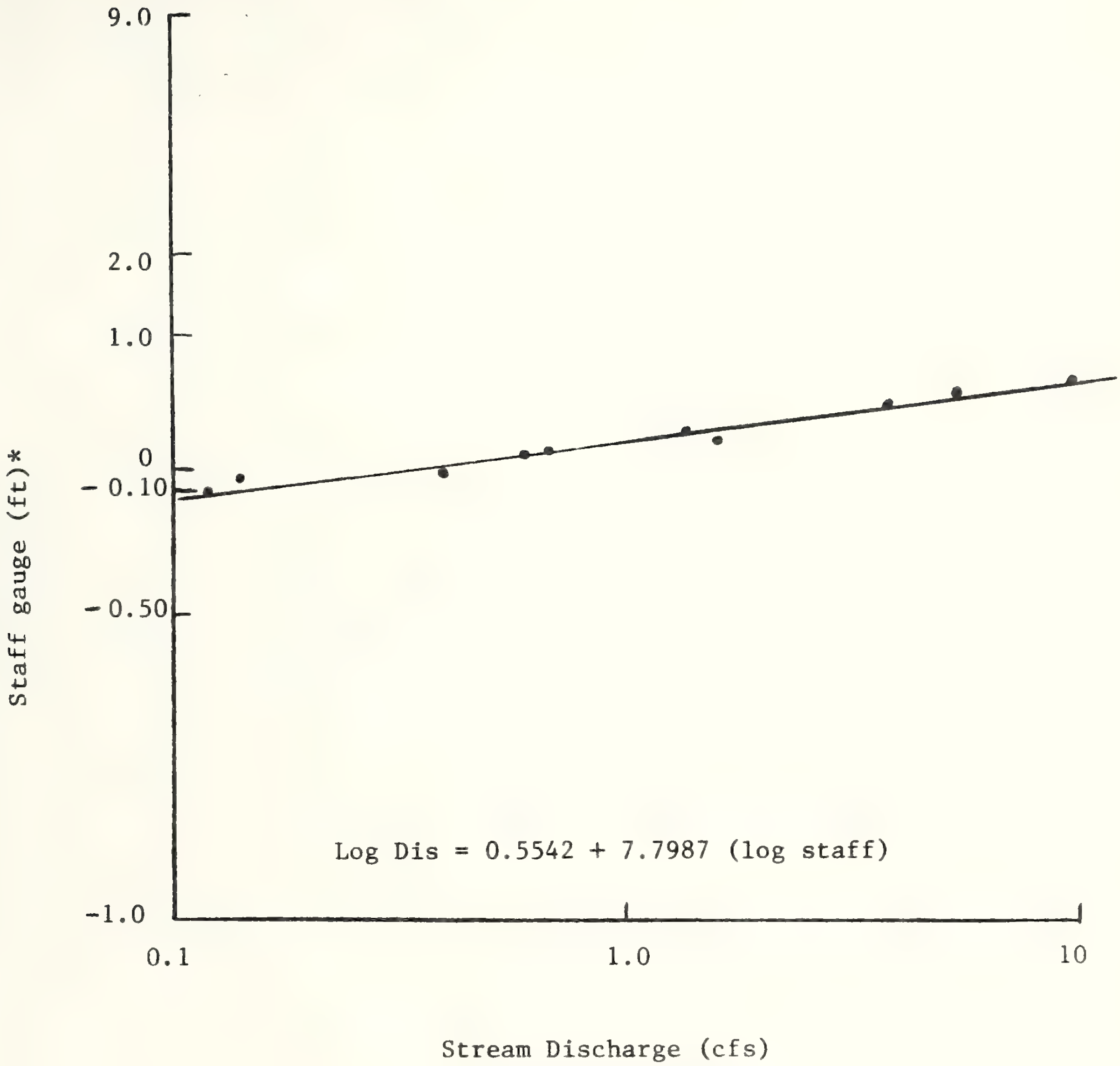


Figure 26. Staff-discharge Rating Curve for Lower Clark Canyon Sampling Station.

* Owing to actual negative readings, 1.0 feet must be added to each recorded value when using this rating curve.

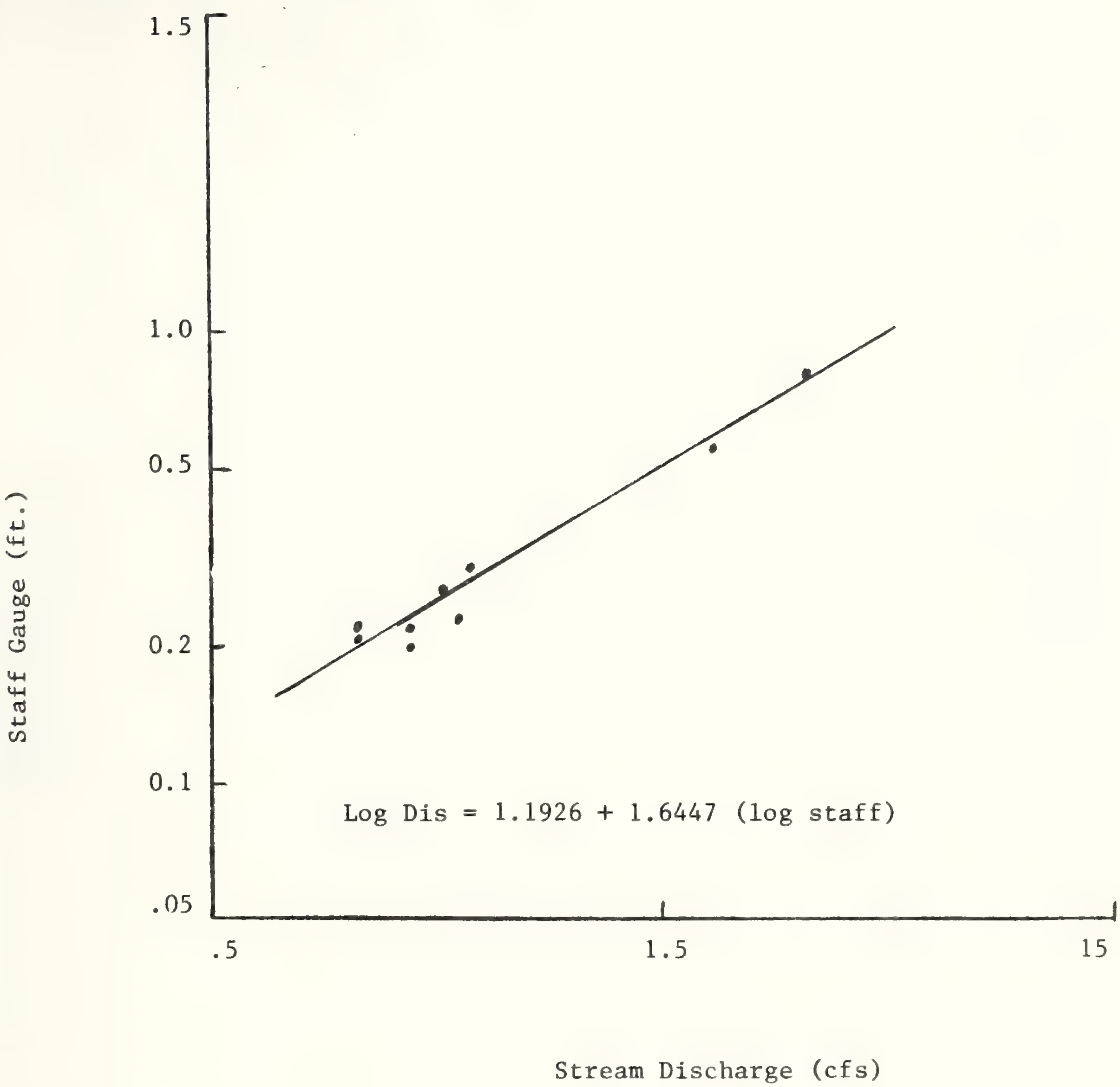


Figure 27. Staff-discharge Rating Curve for Clark Canyon Sampling Station.

FIGURE 28. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER CLARK CANYON - 1977

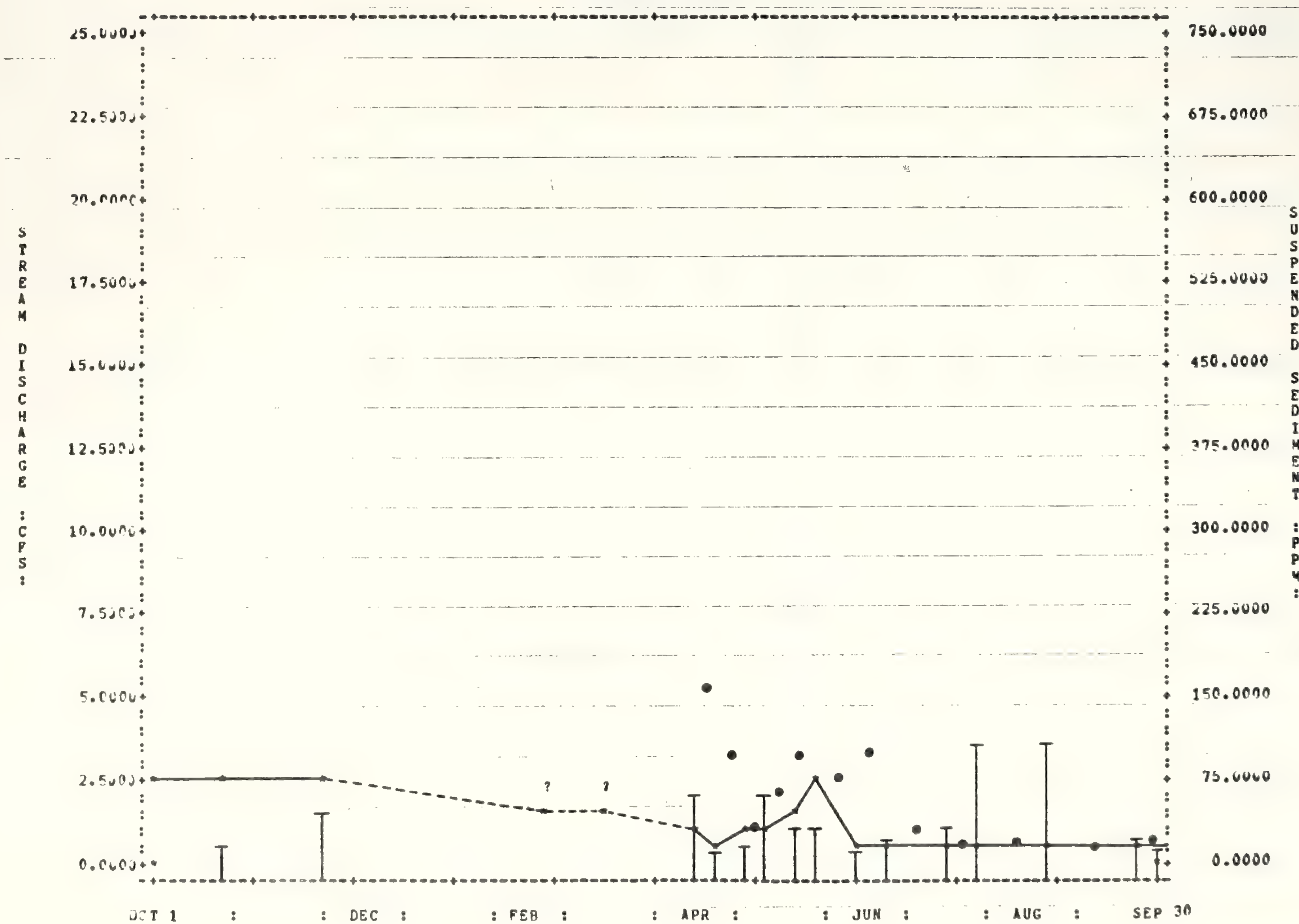


FIGURE 29. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER CLARK CANYON - 1978

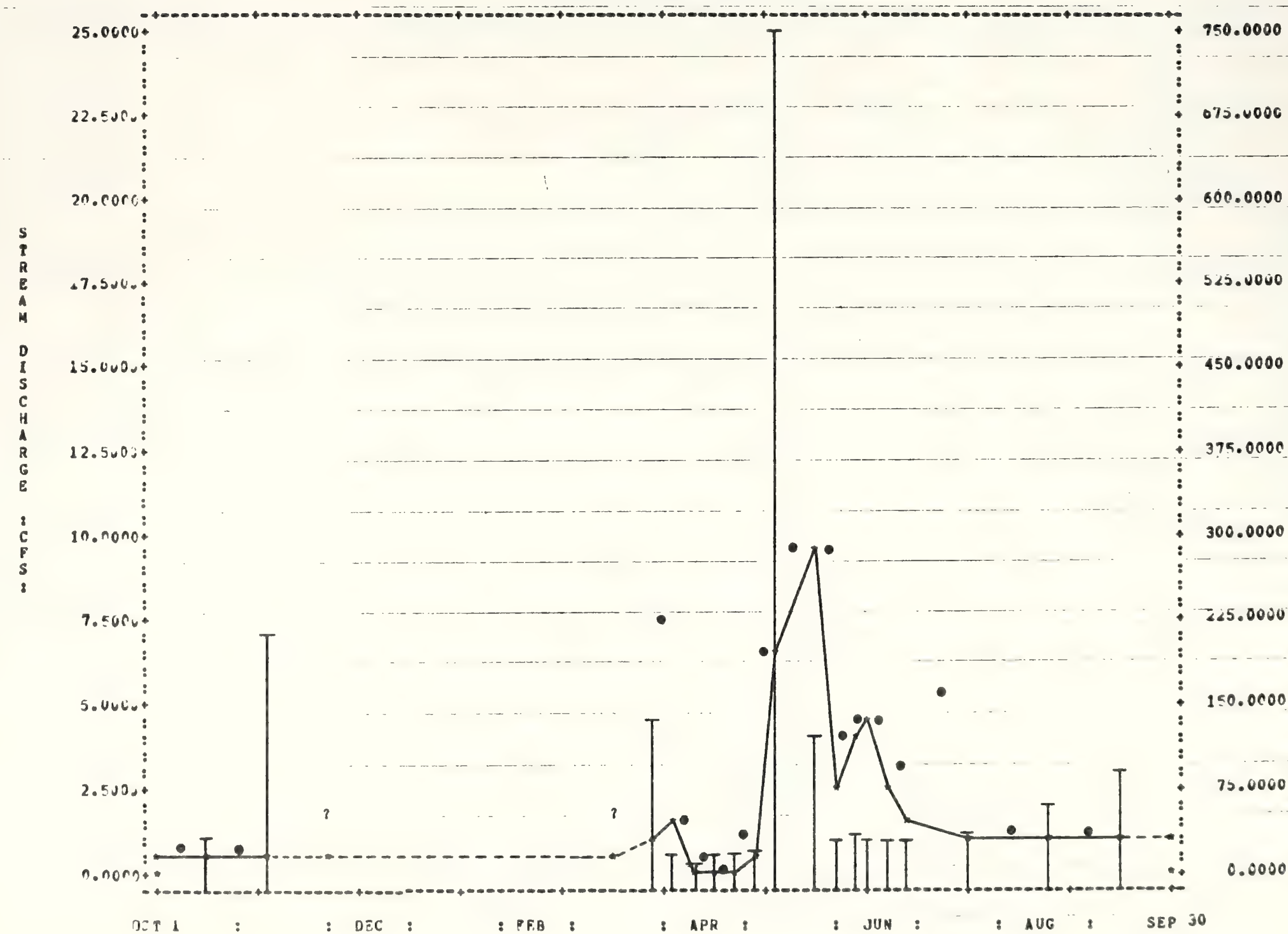


FIGURE 30. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER CLARK CANYON - 1977

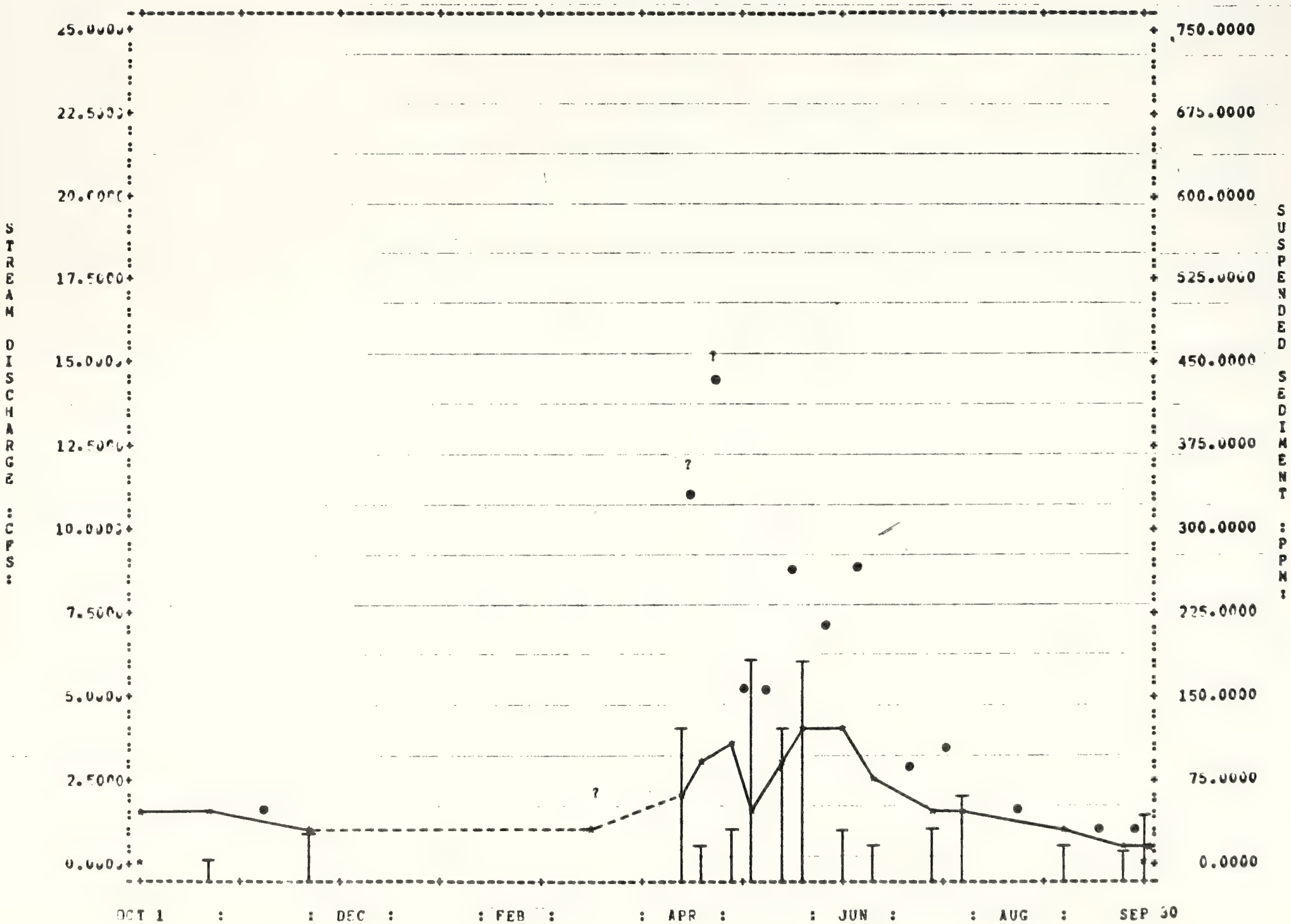


FIGURE 31. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER CLARK CANYON - 1978

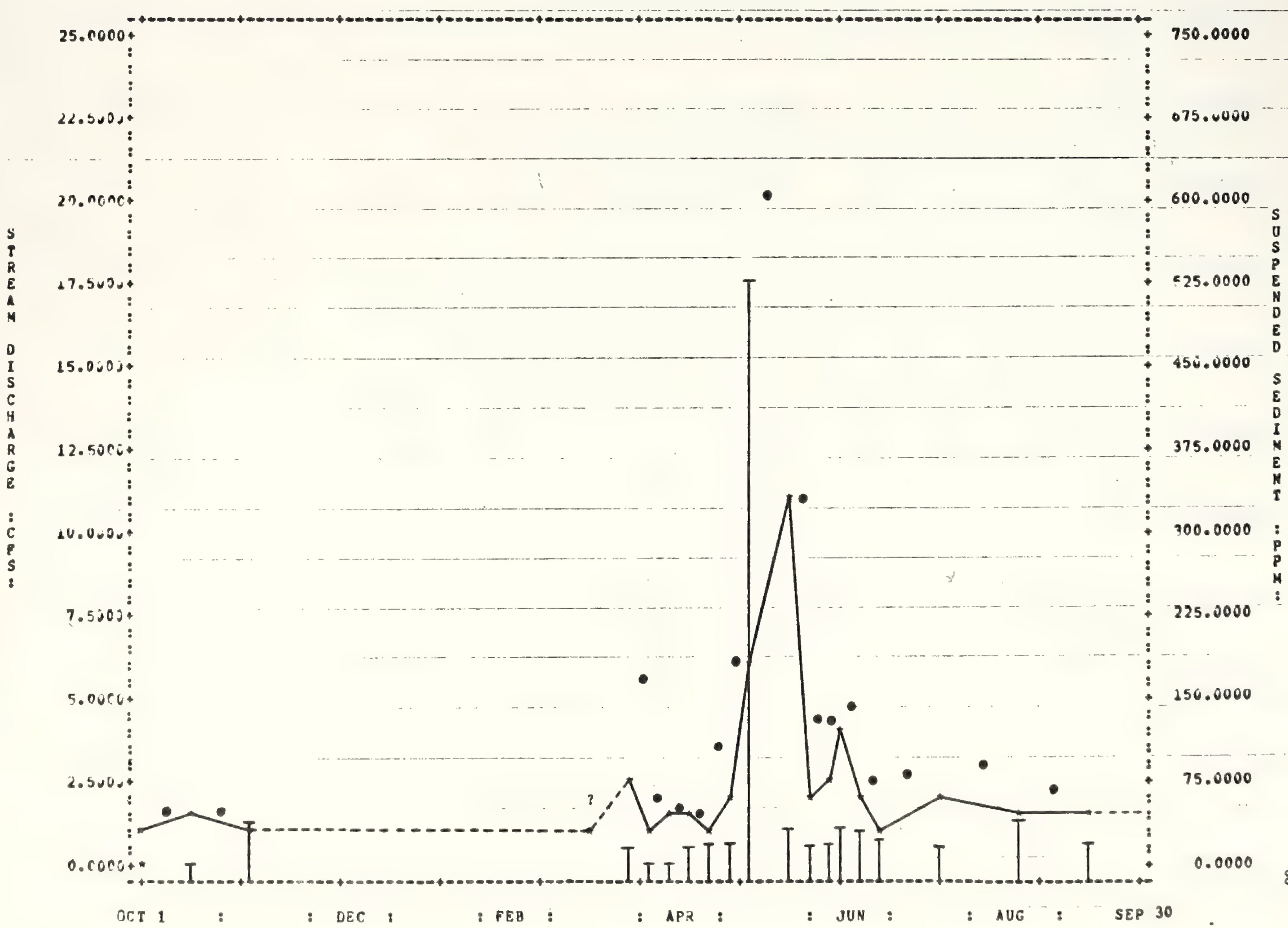
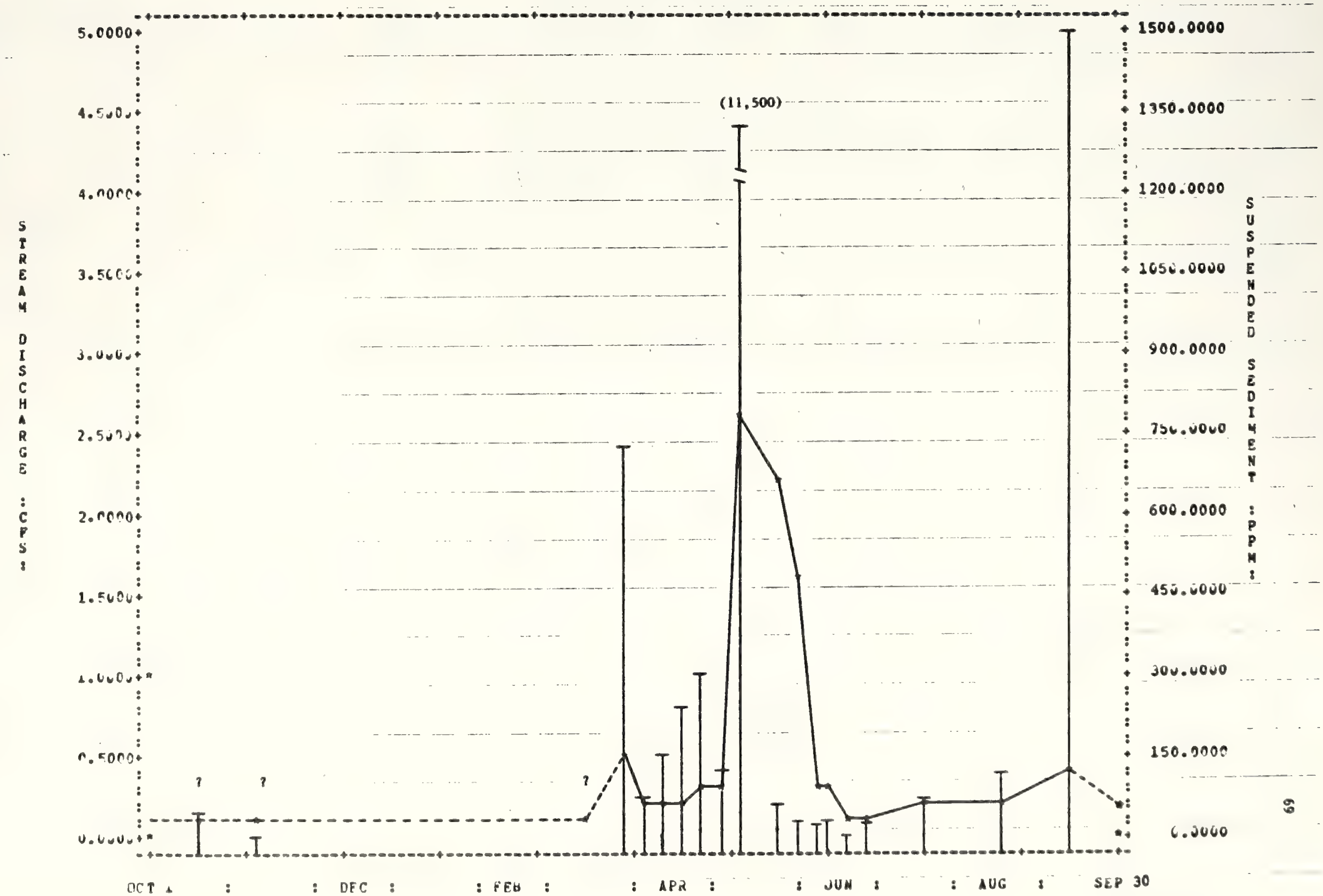


FIGURE 32. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

EAST FORK CLARK CANYON - 1978



0.69 cfs in mid-September. Peak flow in 1978 arrived during mid-May with an estimated 20 cfs, while the annual lowest flow was recorded at 0.76 cfs the preceeding November. Discharge values at the initial East Fork sampling station ranged from peak flow that would have been well in excess of 2 cfs in early April to a trickle in July and August. Peak recorded flow for the East Fork station for 1978 at its new location was 2.6 cfs in mid-May, while the low annual flow of 0.10 cfs occurred in late June. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation patterns, although the East Fork station responded specifically to individual storm periods.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 10). In both years, the estimated yield for the Lower Clark Canyon station was slightly below that of the Upper station owing to largescale irrigation diversions. Yields for the two year study period were comparable, ranging from 980 acre feet to 1,250 acre feet. Discharge for one large storm period in May, 1978 may have overestimated the 250 acre feet water yield figure for the East Fork station.

Suspended Sediment

The annual patterns of sediment concentration for each station by hydrologic year are depicted in Figures 28-32. Suspended sediment concentrations at the Lower Clark Canyon station ranged from 7 ppm at low flow to 744 ppm at high flow, the Upper station from 7 ppm to 525 ppm, while the East Fork station values extended from 15 ppm to 11,500 ppm. Higher suspended sediment values were recorded during the 1978 hydrologic year when there were higher discharge values. The relationships between suspended sediment and stream discharge for Lower Clark Canyon and Upper Clark Canyon were statistically significant, and are presented in Figures

Table 10 Estimated Water and Sediment Yields for the Clark Canyon Sample Basin, 1977 - 1978.

Station Name	Water Year	Estimated Water Yield (ac. - ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in./ ac.)	Sediment Yield (lbs/acre)
Lower Clark Canyon Station	1977	980	48	9,730	1.21	9.93
	1978	1,020	227	9,730	1.26	46.4
Upper Clark Canyon Station	1977	1,110	81	5,380	2.48	29.9
	1978	1,250	127	5,380	2.79	47.2
East Fork Clark Canyon Station	1977	N/A	--	--	--	--
	1978	250	410	1,660	1.80	500

33 and 34. The suspended sediment vs discharge relationship (Figure 35) for the East Fork station for 1978 was not significant, primarily owing to the variability of the data and the small sample size. This variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, and especially to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for those sample stations were estimated from respective water yield and sediment concentration data (Table 10). The Lower and Upper stations produced approximately 48 tons and 81 tons of suspended sediment respectively during 1977. These yields were increased to 227 tons and 127 tons for the more active 1978 hydrologic year. The estimated suspended sediment yield of 250 tons for the East Fork is an approximation based on an adjusted figure for the storm period encompassing May 9, 1978.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Clark Canyon station ranged from a low of 284 µmhos during high spring runoff to a high of 515 µmhos during late summer base flow. The Upper Clark Canyon station exhibited a much greater seasonal variation, values ranging from 205 µmhos to a high of 427 µmhos, while the East Fork station ranged from 178 µmhos to 600 µmhos.

FIGURE 33. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER CLARK CANYON

LOG SED = 1.5356 +0.3922(LOG DIS)

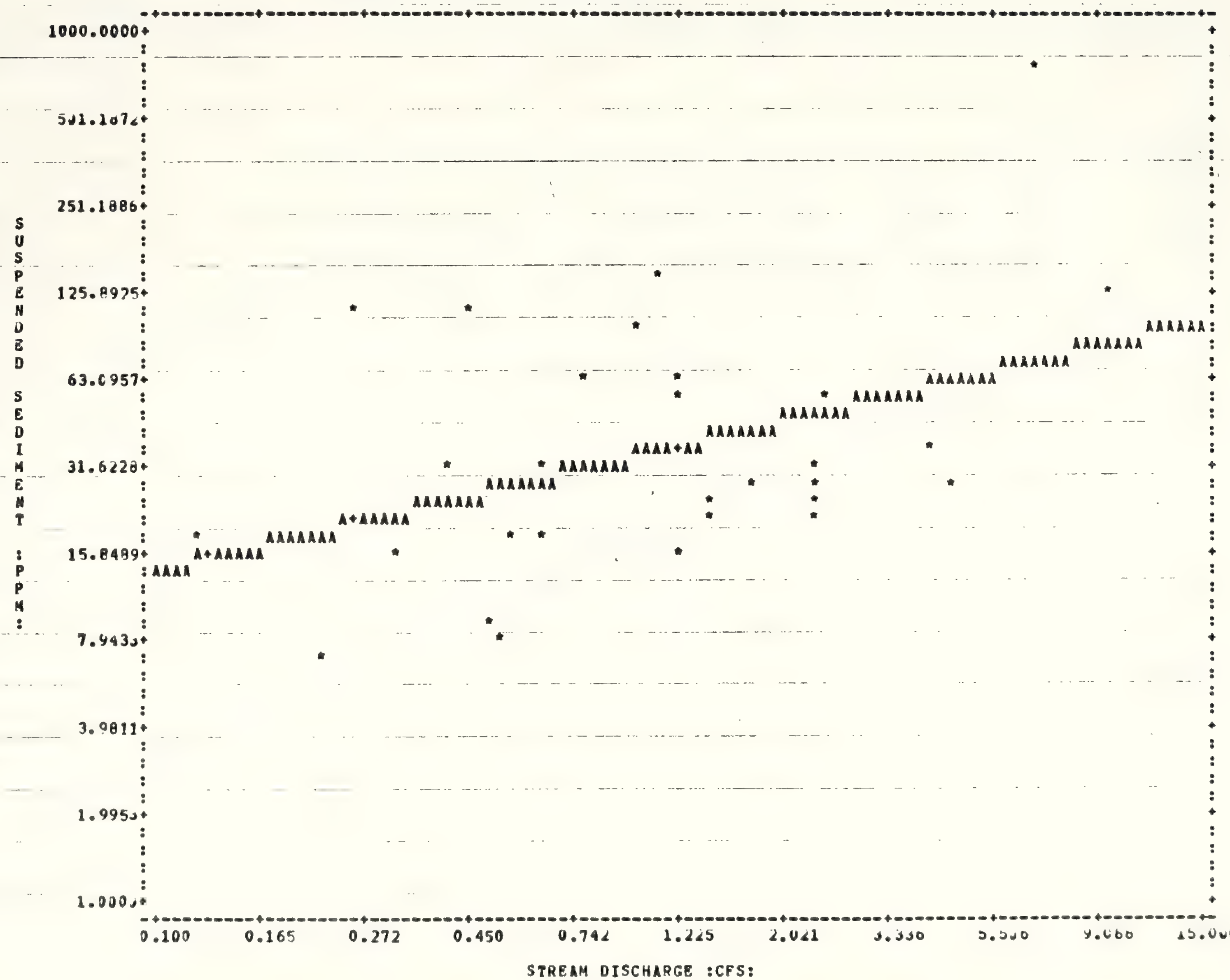


FIGURE 34. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER CLARK CANYON

LOG SED = 1.2119 + 0.7086(LOG DIS)

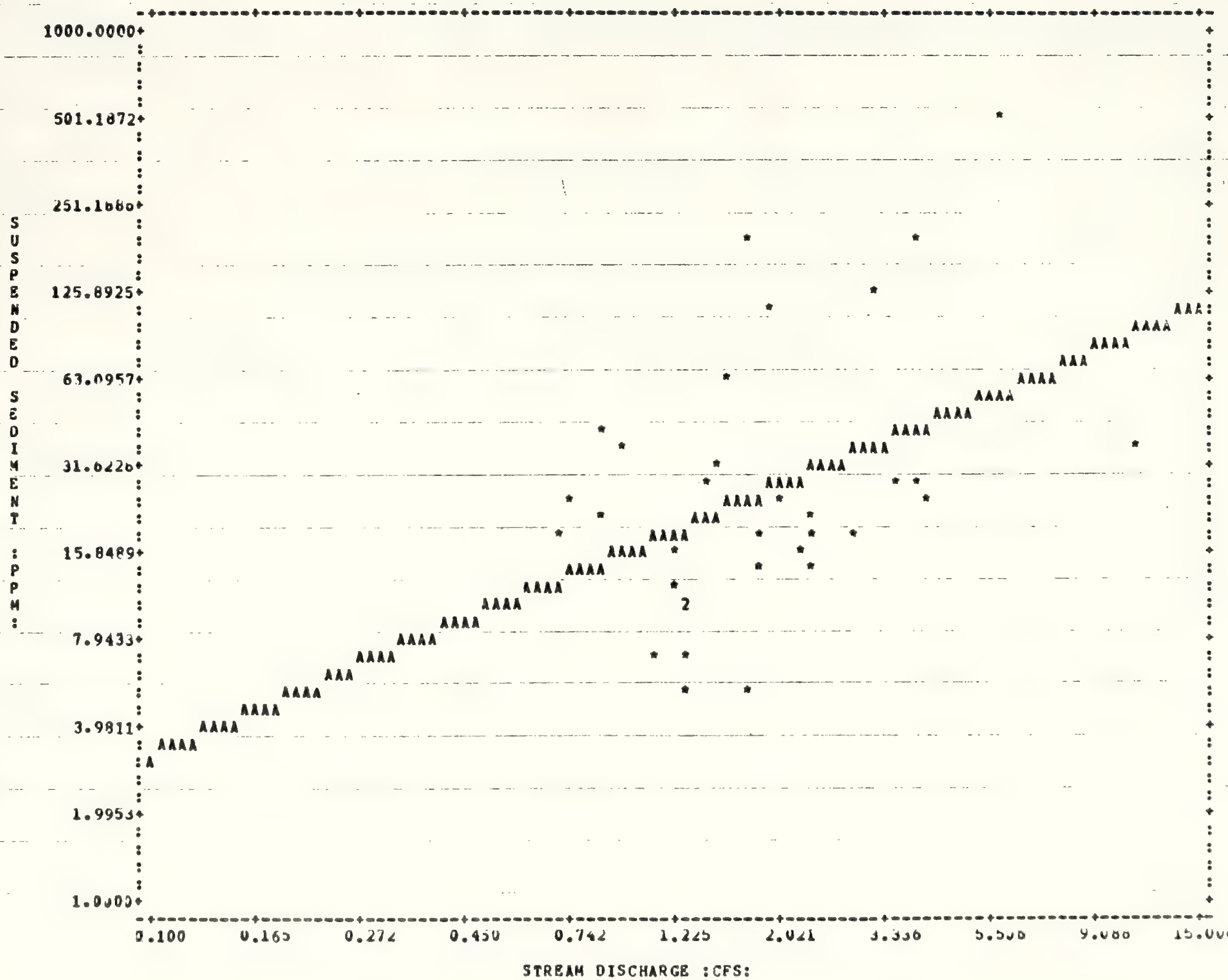
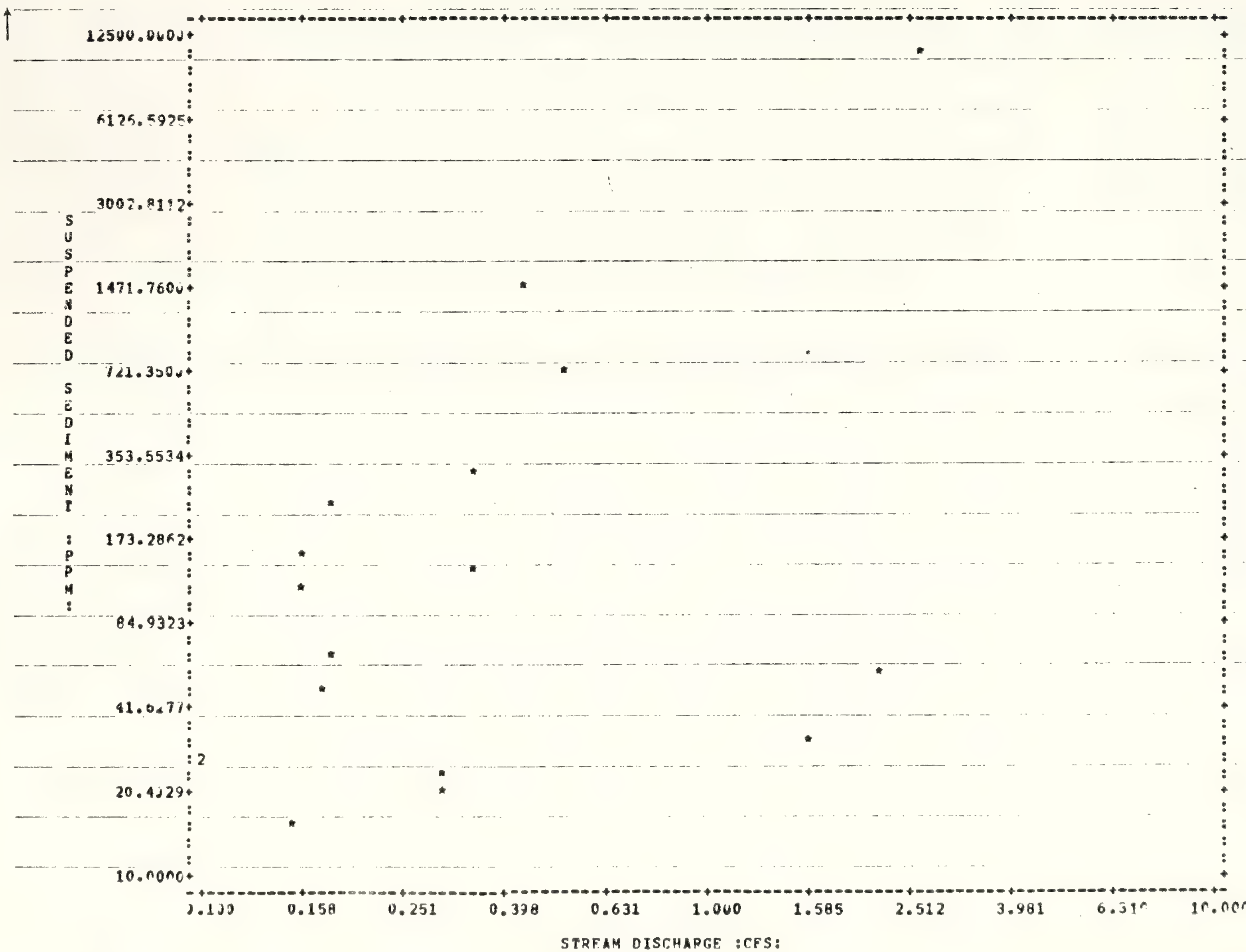


FIGURE 35. SUSPENDED SEDIMENT VS STREAM DISCHARGE - EAST FORK CLARK CANYON



The relationships between specific conductance and stream discharge for each station were statistically significant and are presented in Figures 36-38. Variation in specific conductance with stream discharge is partially attributed to seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 11.

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Clark Canyon Creek sampling stations for the study period are presented in Table 12. Higher values generally occurred during the grazing season, especially at the Lower and Upper stations with the known present of livestock. The data indicate that livestock were present in the East Fork watershed. Maximum fecal coliform levels were 409, 387, and TNTC colonies/100 mls respectively for each station. Approximately 8 percent of the sample colonies counts in Lower Clark Canyon, 8 percent in Upper Clark Canyon, and 33 percent in the East Fork exceeded

FIGURE 36. CONDUCTIVITY VS STREAM DISCHARGE - LOWER CLARK CANYON

LOG COND = 2.6139 - 0.0572(LOG DIS)

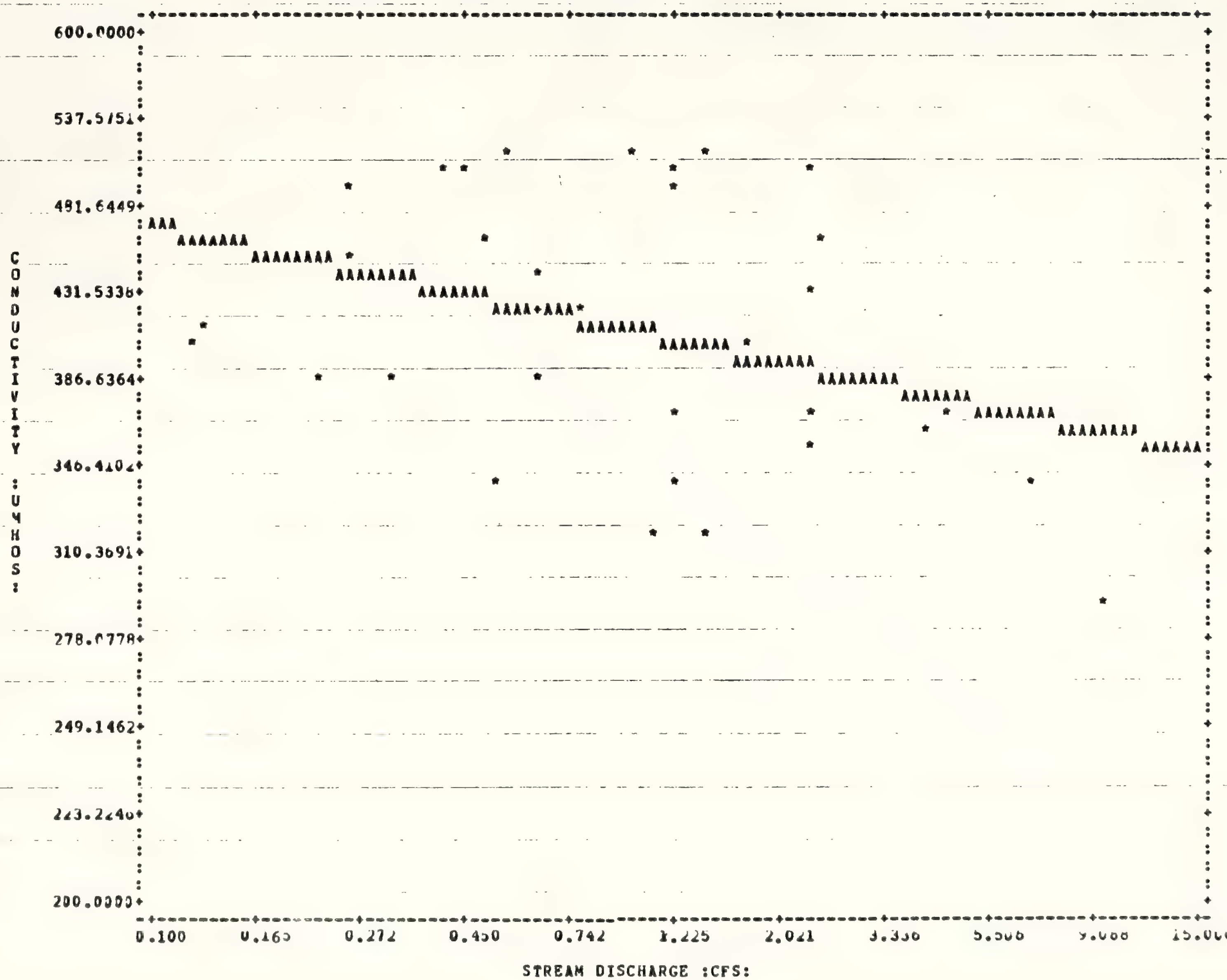


FIGURE 37. CONDUCTIVITY VS STREAM DISCHARGE - UPPER CLARK CANYON

LOG COND = 2.561 - 0.213(LOG DIS)

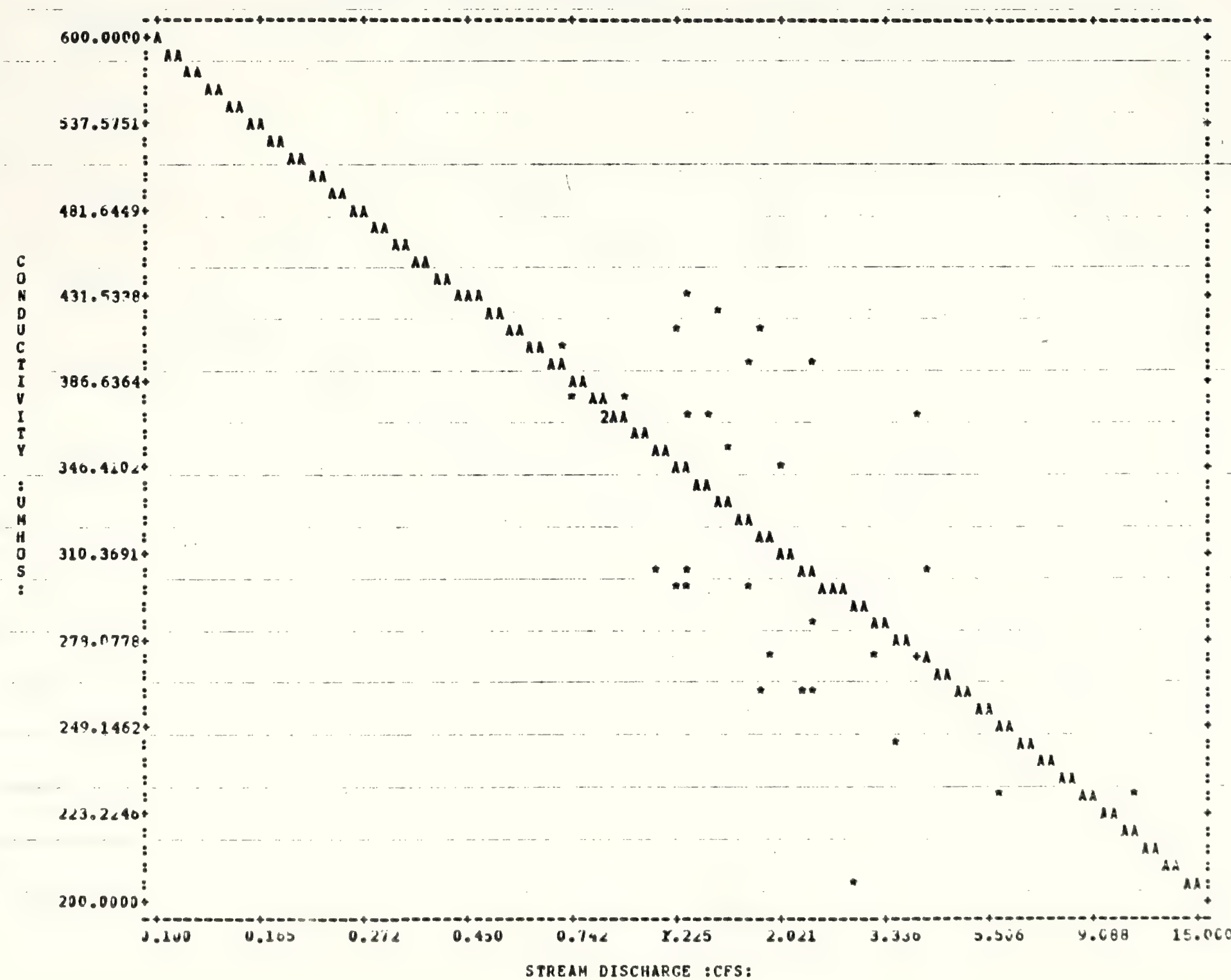


FIGURE 38. CONDUCTIVITY VS STREAM DISCHARGE - EAST FORK CLARK CANYON

LOG COND = 2.3474 - 0.1701(LOG DIS)

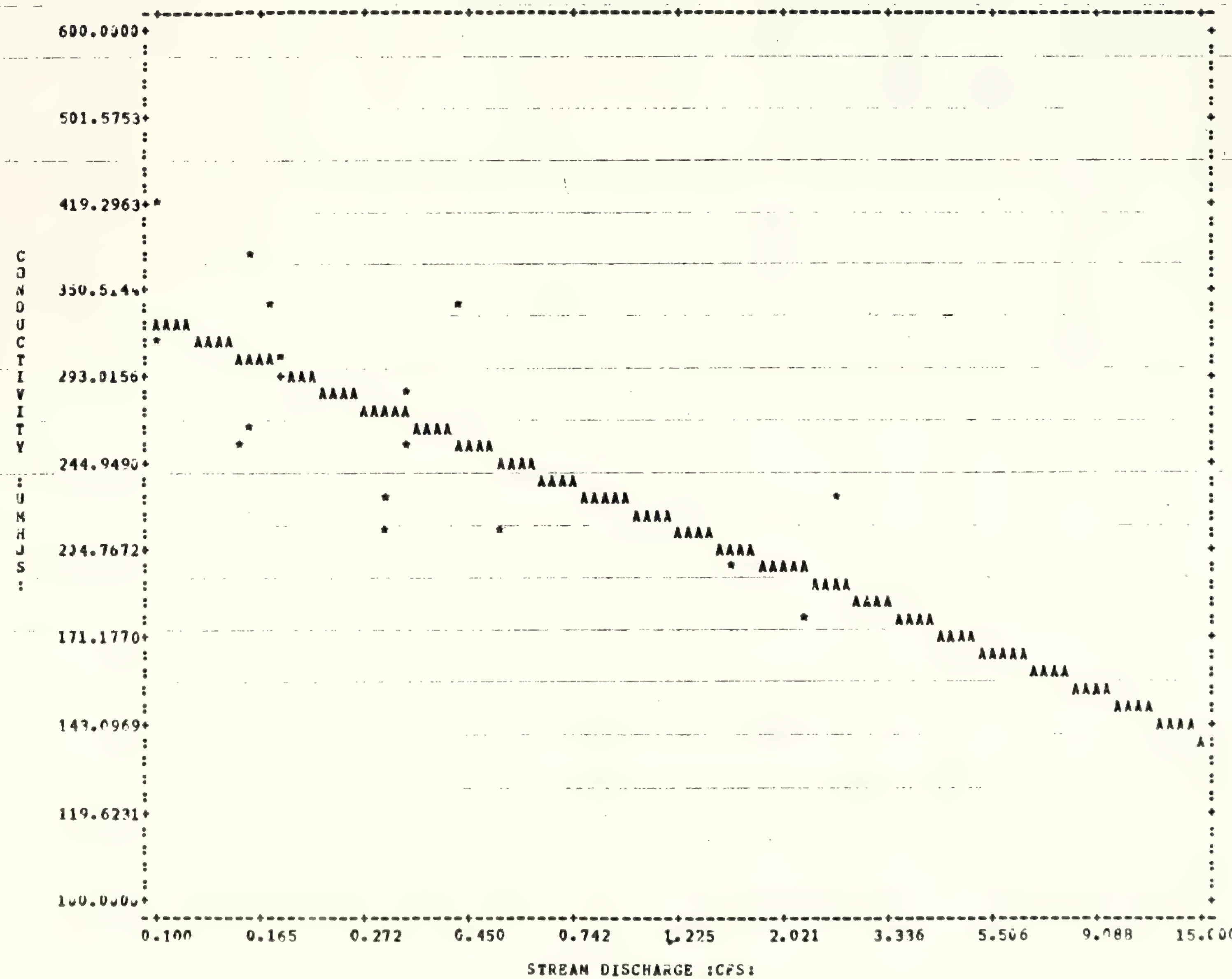


Table 11 Ranges in Hydrochemical Parameters for the Clark Canyon Creek Sampling Stations, 1977 - 1978.

	Lower Clark Canyon	Upper Clark Canyon	East Fork Clark Canyon
pH	7.70 - 8.27	7.76 - 8.20	7.70 - 8.37
Alkalinity ($CaCO_3$) (mg/l)	148 - 275	111 - 214	85 - 281
Specific Conductance (umhos)	284 - 515	205 - 427	178 - 600
Total Dissolved Solids (mg/l)	185 - 335	133 - 278	116 - 390
Ca (mg/l)	37 - 92	24 - 78	19 - 64
Mg (mg/l)	4.1 - 8.4	3.3 - 7.4	2.7 - 11
Na (mg/l)	17 - 31	10 - 19	15 - 58
K (mg/l)	1.4 - 5.6	1.3 - 3.5	2.9 - 8.5
HCO_3 (mg/l)	178 - 336	136 - 260	102 - 343
SO_4 (mg/l)	4 - 12	3 - 9	5 - 32
NH_4 (mg/l)	$<$ .01 - .14	$<$ .01 - .25	$<$ .01 - .13
$NO_2 + NO_3 - N$ (mg/l)	$<$ .01 - .10	.02 - .40	$<$ .01 - .08
PO_4 (Ortho) -P (mg/l)	.001 - .055	.018 - .053	.030 - .108

Table 12 Fecal Coliform Counts (colonies 100/mls) for the Clark Canyon Creek Sampling Stations, 1977 - 1978.

	Lower Clark Canyon		Upper Clark Canyon		East Fork Clark Canyon	
	1977	1978	1977	1978	1977	1978
April	--		--		--	
May	<2	<1	<2	1	4(?)	3
June	8(?)	409*	8(?)	9	8(?)	28(?)
July	14*	100(?)	<2*	387*	940(?)	267(?)
August	2*	83(?)	8(?)	33*	140(?)	303(?)
September	143*	87(?)	14*	9(?)	TNTC(?)	33(?)
October	51*		7(?)		5*	
November	58*		17(?)		65*	

* Stock visually present.

(?) Stock presence uncertain.

the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

Comments

While the Upper Clark Canyon station reflects characteristic hydrologic patterns, the Lower and East Fork stations reflect contrasting patterns. The Lower station is strongly influenced by the effects of irrigation diversion and several elevated sediment concentrations may be attributed to the presence of livestock. The East Fork of Clark Canyon is steep and faces to the southwest. It is prone to rapid runoff during storm periods or during early spring melt. The channel is unstable and is constantly altering its morphonetry. This small stream carries disproportionally large quantities of suspended sediment as well as bed load. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Clark Canyon Creek and the Montana Water Quality Criteria cannot be addressed.

Little Sage Creek Basin

The Little Sage Creek sample basin was visited a total of 16 and 17 times during the two hydrologic years. There were no specific accessibility or sampling problems.

Channel Stability Ratings

The Little Sage Creek stream section was evaluated on August 15, 1976. That portion of Little Sage Creek upstream from the sampling station for approximately 4 1/2 miles was rated as 'good' (67) (Table13).

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Table 13

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Little Sage
8/15/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 4	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	7
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	~~(8)~~ 6	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	~~(8)~~ 6	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	~~(12)~~ 9	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		8		34		18		7

Add the values in each column for a total reach score here. (E. 8 + G. 34 + F. 8 + P. 7 = 67).

Reach score of: <38=Excellent, 39-76=Good, 77-114= Fair, 115+=Poor.

R1-2500-5 (6

Precipitation

Precipitation was measured at the Little Sage precipitation station from April 21 through November 13, 1977 and from April 4 through September 11, 1978. The general precipitation patterns during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 39). Although 1977 was the wetter year, both years indicate a peak in precipitation for May and September.

Stream Discharge

The staff-discharge rating curve for the Little Sage Creek sample station is presented in Figure 40. The guaging site remained nearly stable during the two sampling years.

The 1977 and 1978 annual hydrographs for the Little Sage Creek sample station are presented in Figures 41 and 42. Peak flow during 1977 at the Little Sage station was recorded in late April. An estimated crest stage value of 3.5 cfs was recorded at this time, although a higher flow may have occurred prior to the first sampling visit. The crest stage peak flow may be overestimated owing to residual ice conditions around the staff guage. The lowest recorded flow during 1977 was only 0.69 cfs during early May. The 1978 year produced no discernible peak, although one may have occurred prior to the first sampling visit. The lowest recorded flow for 1978 was 0.50 cfs in mid-July. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation and snow melt patterns.

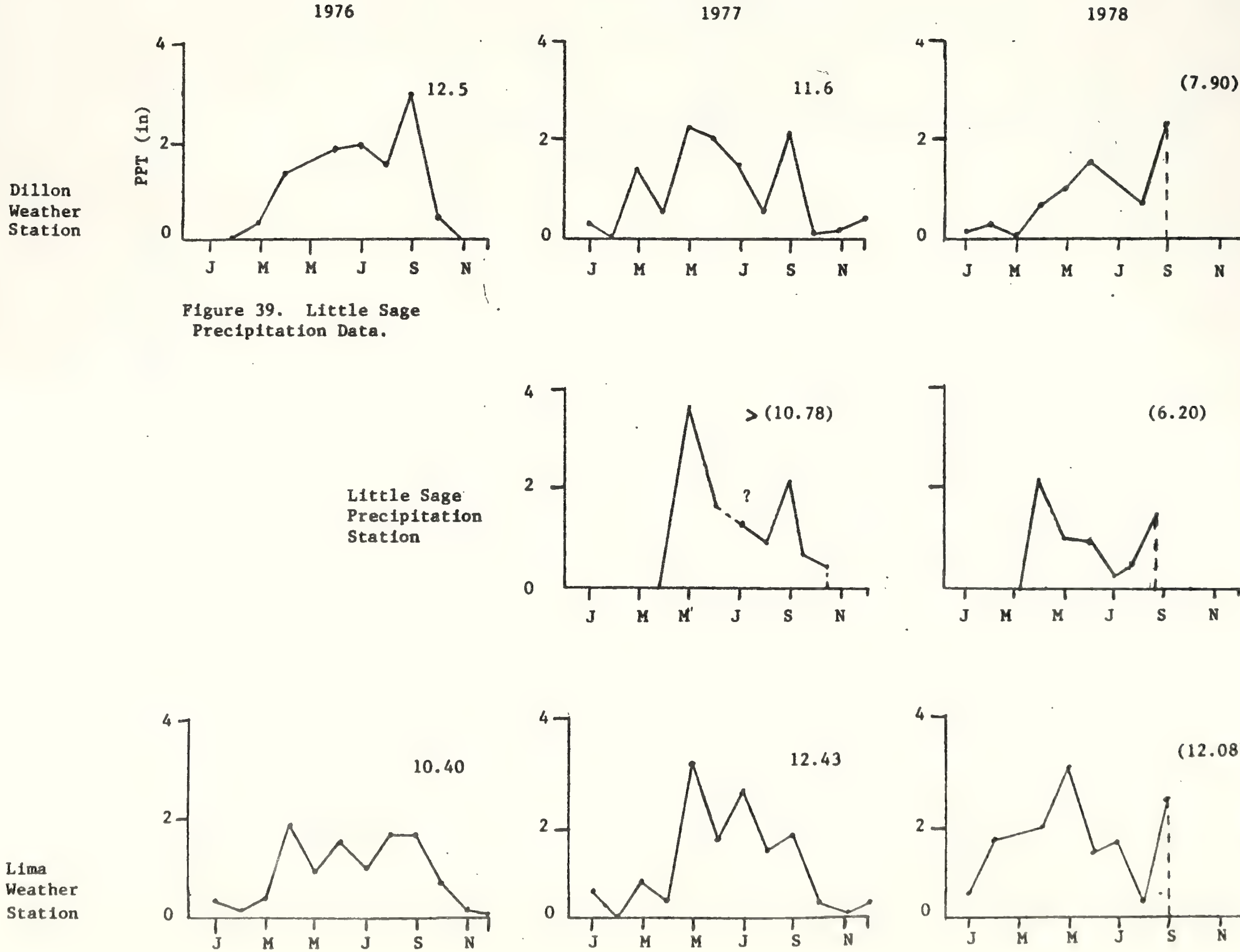


Figure 39. Little Sage Precipitation Data.

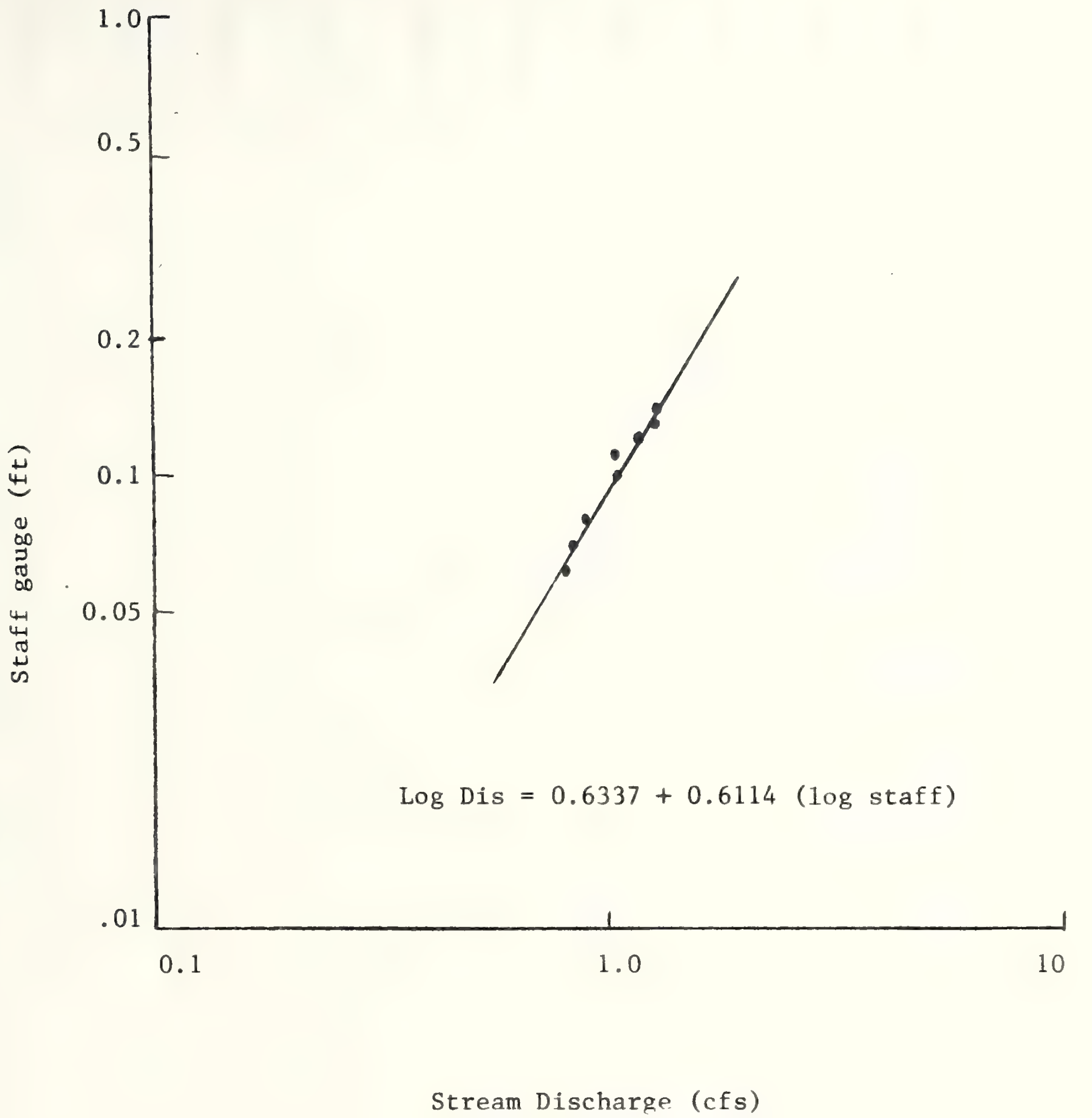


Figure 40. Staff-discharge Rating Curve for Little Sage Sampling Station.

FIGURE 41. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LITTLE SAGE - 1977

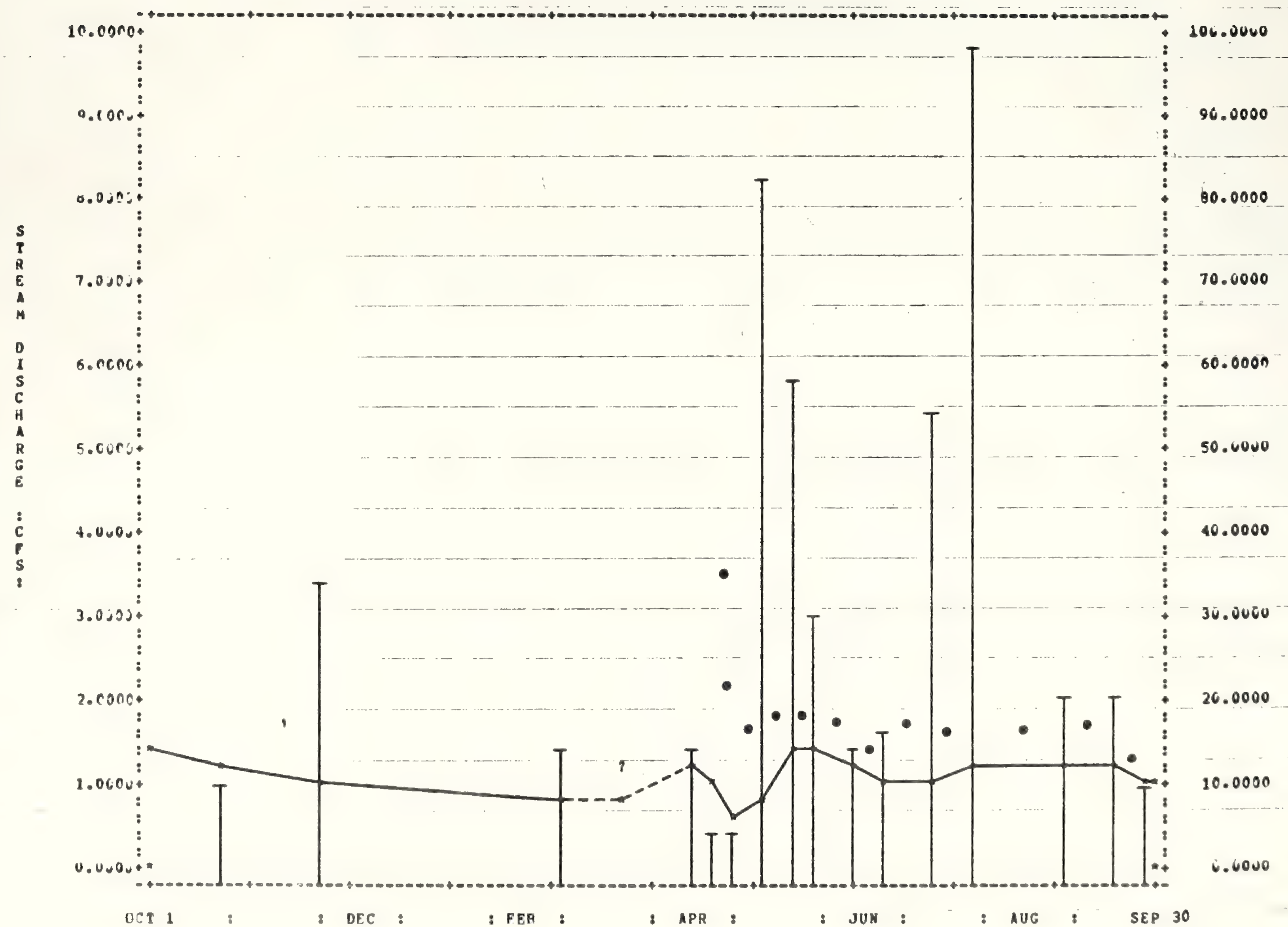
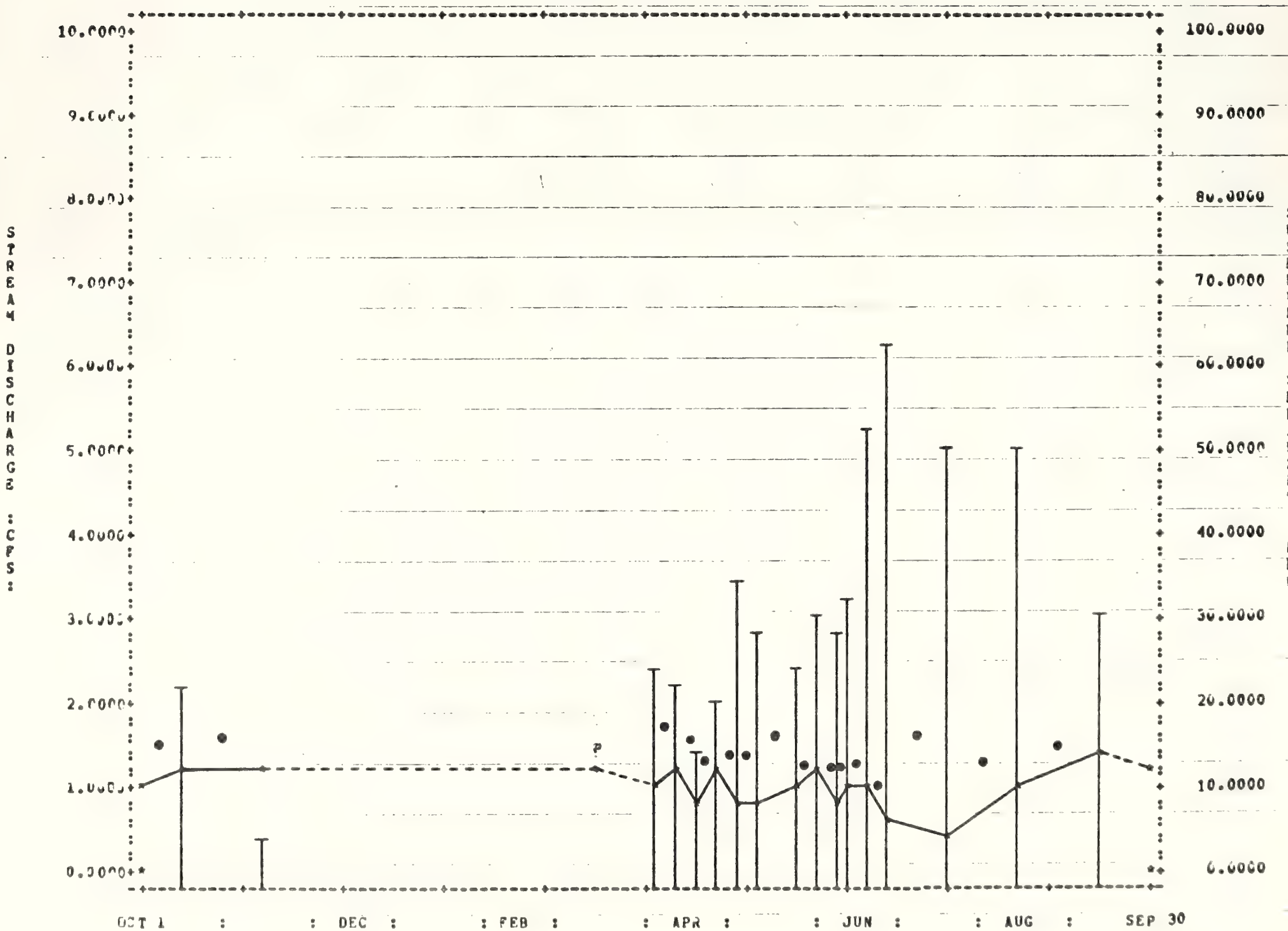


FIGURE 42. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LITTLE SAGE - 1976

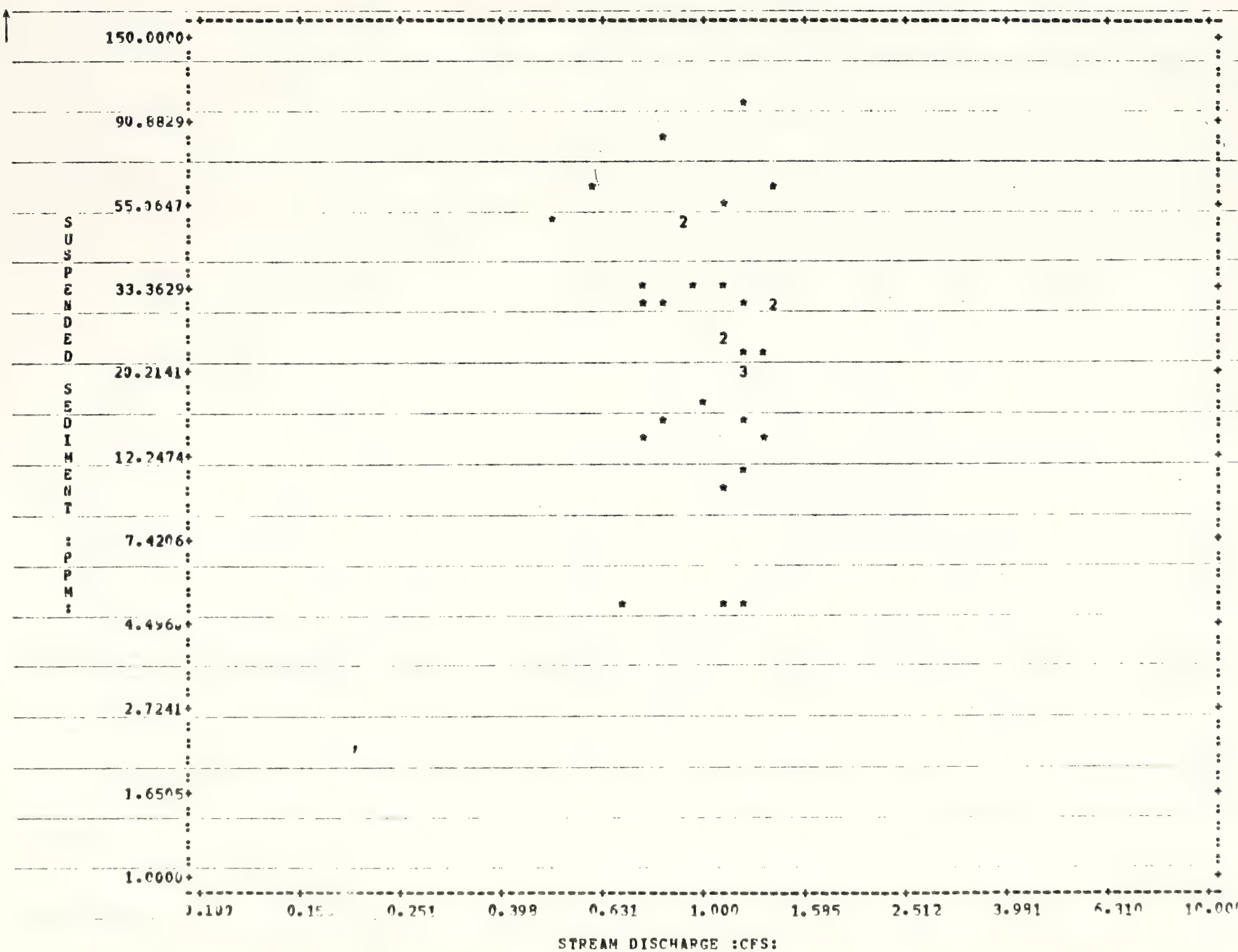


The respective annual hydrograph data were used to estimate the annual water yields for the Little Sage Creek Table 19, see p. 111). In both water years the estimated yield was 780 acre feet. This condition is partially attributed to the gentle topography of much of the basin, and to the possible ommission of a recorded spring peak flow for one or both sampling years.

Suspended Sediment

The annual patterns of sediment concentration for the Little Sage for each hydrologic year are depicted in Figure 41 and 42. Suspended sediment concentrations at the station ranged from 5 ppm at low flow to a high of 99 cfs which was not associated with high discharge values. The relationships between suspended sediment and stream discharge for this station were not statistically significant (Figure 43). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, the presence of livestock in and near the stream, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the sample station were estimated from respective water yield and sediment concentration data (Table 19, see p. 111). The station produced approximately 31 tons and 21 tons of suspended sediment respectively during the study years. These differences are partially attributed to differences in the precipitation and hydrologic regimes between the two years.

FIGURE 43. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LITTLE SAGE



Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Ralling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Little Sage station ranged from a low of 292 μmhos to a high of 428 μmhos. The relationships between specific conductance and stream discharge for the Little Sage station were not statistically significant (Figure 44) and did not conform to the pattern noted above. The variation in specific conductance with stream discharge is believed to be primarily attributed to the low slope - low runoff conditions of the basin and secondarily to the usual seasonal and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225). The ranges in ionic concentration for specific ions are presented in Table 14.

Bacteria Levels

The concentration of fecal and total coliform in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1968), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from

FIGURE 44. CONDUCTIVITY VS STREAM DISCHARGE - LITTLE SAGE

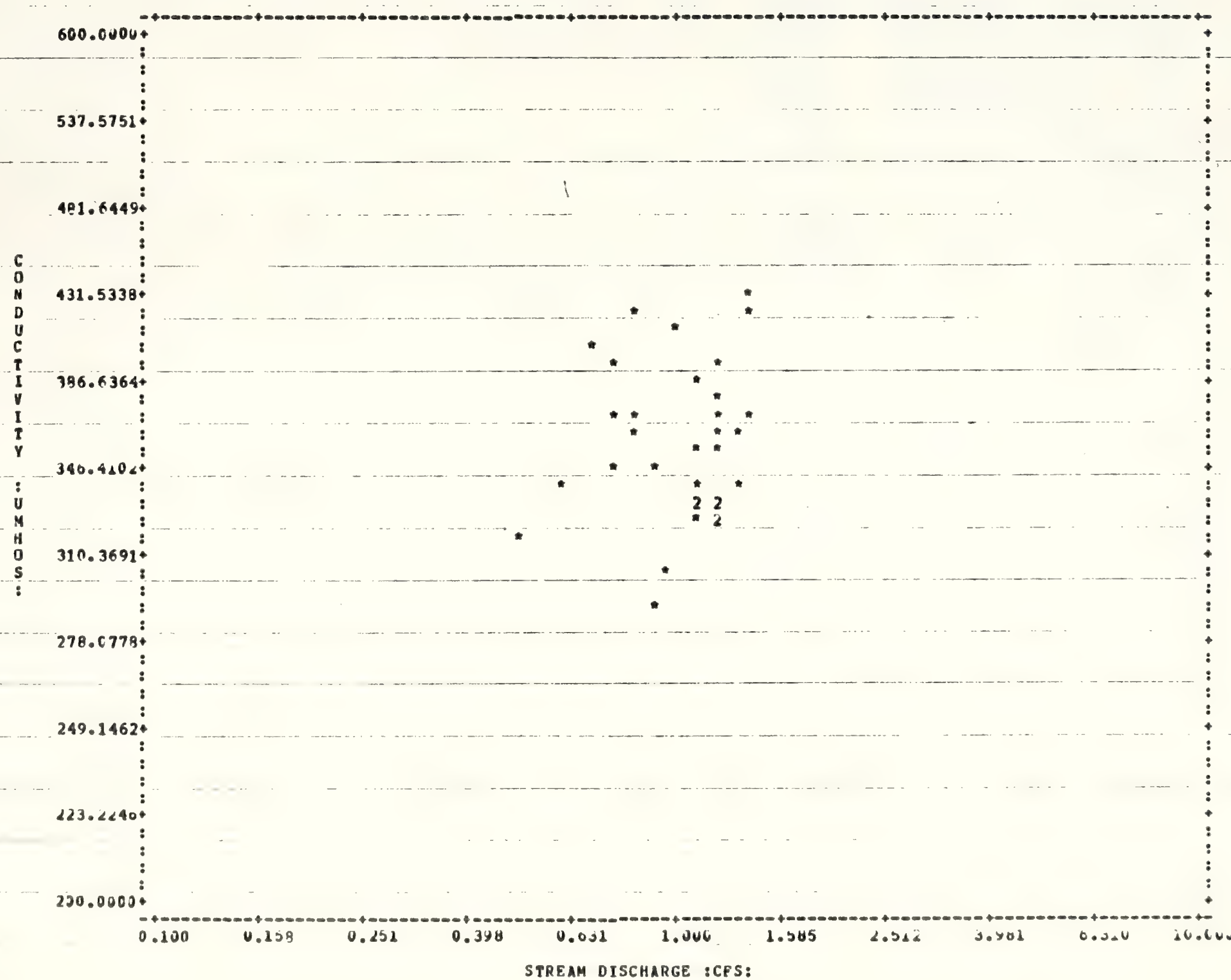


Table 14. Ranges in Hydrochemical Parameters for Little Sage Creek, 1977 - 1978.

	Little Sage
pH	7.70 - 8.60
Alkalinity ($CaCO_3$) (mg/l)	148 - 210
Specific Conductance (umhos)	292 - 428
Total Dissolved Solids (mg/l)	190 - 278
Ca (mg/l)	38 - 70
Mg (mg/l)	7.3 - 11
Na (mg/l)	9.8 - 14
K (mg/l)	5.4 - 8.5
HCO_3 (mg/l)	170 - 256
SO_4 (mg/l)	2 - 8
NH_4 (mg/l)	< .01 - .09
NO_2 + NO_3 - N (mg/l)	.01 - .14
PO_4 (Ortho) - P (mg/l)	T - .086

the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Little Sage station for the study period are presented in Table 15. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 2,000 colonies/100 mls. Twenty-five percent of the sample coliform counts exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Low values were associated with the spring season.

Comments

Little Sage Creek is a very gentle, high elevation, dryland basin. This suite of environmental conditions may retard the normal annual flushing effect encountered in other environments. Thus, neither suspended sediment concentraion nor conductivity was correlated with stream discharge. In addition, there is some indication that livestock influenced sediment concentrations on several occasions. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated, relationships between the water quality characteristics of Little Sage Creek and the Montana Water Quality Criteria cannot be addressed.

Basin Creek Basin

The Basin Creek Sample basin was visited a total of 16 and 17 times during the two hydrologic years. There were no specific accessibility or sampling problems. The Upper Basin and Little Basin monitored 15 and 17 times respectively.

Table 15. Fecal Coliform Counts (colonies/100 mls) for Little Sage Creek, 1977 - 1978.

	Little Sage	
	1977	1978
April		--
May	12(?)	2
June	390*	17(?)
July	488*	29(?)
August	50(?)	85(?)
September	9(?)	2000 *
October	18*	
November	8*	

* Stock visually present.

(?) Stock presence uncertain.

Channel Stability Ratings

The Lower Basin Creek, Upper Basin Creek, and Little Basin Creek stream sections were evaluated on August 16, 1976. That portion of Basin Creek between the lower station and the two tributary stations was rated as 'good' (49) (Table 16), Upper Basin Creek as 'good' (74) (Table 17), and Little Basin Creek as 'good' (67) (Table 18).

Precipitation

Precipitation was measured at the Upper Basin precipitation station from April 21 through November 13, 1977 and from April 4 through September 11, 1978. The general precipitation patters during these two fiscal years are compared to those of the Dillon and Lima weather stations (Figure 45). Apparently 1977 was the wetter year for the Basin Creek station, primarily owing to greater precipitation in the spring.

Stream Discharge

The staff-discharge rating curves for the Lower Basin, Upper Basin and Little Basin sample stations are presented in Figures 46-48. The gauging sites remained nearly stable during the two sampling years. Rocky substrate in Lower and Upper Basin stations caused low flow threshold values in the rating curves.

The 1977 and 1978 annual hydrographs for the Basin Creek sample stations are presented in Figures 49-54. Peak flow during 1977 at the Lower Basin station apparently occurred in mid-April. An estimated crest stage value of 15 cfs was recorded; however, residual ice in the channel may have overestimated this flow. The lowest recorded flow during 1977 was 0.49 cfs during mid-July. The 1978 year produced an early peak flow of 6.7 cfs in late-April which preceeded a possibly overestimated seasonal peak discharge of 14 cfs

USDA-FOREST SERVICE

Table 16

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Lower Basin
8/16/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3) 2	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4)	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6)	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8)	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8) 6	Moderate change in sizes. Stable materials 20-50%.	(12)	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12) 7	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18)	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
	COLUMN TOTALS →	19	→	21	→	9	→	

Add the values in each column for a total reach score here. (E. 19 + G. 21 + F. 9 + P. ___ = 49).

Reach score of: <38=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

R1-2500-5 (6

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Table 17

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Upper Basin
8/16/76

Item Rated	Stability Indicators by Classes							
	EXCELLENT		GOOD		FAIR		POOR	
I. UPPER BANKS								
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +	8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.	12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4) 3	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.	8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 4	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.	12
II. LOWER BANKS								
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.	4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.	8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4)	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.	8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) 7	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.	16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increas in bar formation, most from coarse gravels.	(8)	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12) 9	Extensive deposits of predominately fine particles. Accelerated bar development.	16
III. BOTTOM								
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.	4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.	4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6) 5	No packing evident. Loose assortment, easily moved.	8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	(12) 9	Marked distribution change. Stable materials 0-20%.	16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) 13	More than 50% of the bottom in a state of flux or change nearly yearlong.	24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.	4
COLUMN TOTALS →		4		22		48		–

Add the values in each column for a total reach score here. (E. 4 + G. 22 + F. 48 + P. – = 74).

Reach score of: <38=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

R1-2500-5 (6

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Table 18

R-1 STREAM CHANNEL STABILITY FIELD EVALUATION FORM

Little Basin
8/16/76

Item Rated	Stability Indicators by Classes								
	EXCELLENT		GOOD		FAIR		POOR		
I. UPPER BANKS									
Landform Slope	Bank slope gradient <30%	(2)	Bank slope gradient 30-40%	(4)	Bank slope gradient 40-60%	(6)	Bank slope gradient 60% +		8
Mass Wasting (Existing or Potential)	No evidence of past or potential for future mass wasting into channels.	(3)	Infrequent and/or very small. Mostly healed over. Low future potential.	(6)	Moderate frequency & size, with some raw spots eroded by water during high flows.	(9)	Frequent or large, causing sediment nearly yearlong OR imminent danger of same.		12
Debris Jam Potential (Floatable Objects)	Essentially absent from immediate channel area.	(2)	Present but mostly small twigs and limbs.	(4) 3	Present, volume and size are both increasing.	(6)	Moderate to heavy amounts, predominantly larger sizes.		8
Bank Protection from Vegetation	90% + plant density. Vigor and variety suggests a deep, dense root mass.	(3)	70-90% density. Fewer plant species or lower vigor suggests a less dense or deep root mass.	(6) 5	50-70% density. Lower vigor and still fewer species form a somewhat shallow and discontinuous root mass.	(9)	<50% density plus fewer species & less vigor indicate poor, discontinuous, and shallow root mass.		12
II. LOWER BANKS									
Channel Capacity	Ample for present plus some increases. Peak flows contained. W/D ratio <7.	(1)	Adequate. Overbank flows rare. Width to Depth (W/D) ratio 8-15.	(2)	Barely contains present peaks. Occasional overbank floods. W/D ratio 15-25.	(3)	Inadequate. Overbank flows common. W/D ratio >25.		4
Bank Rock Content	65% + with large, angular boulders 12" + numerous.	(2)	40 to 65%, mostly small boulders to cobble 6-12".	(4)	20 to 40%, with most in the 3-6" diameter class.	(6)	<20% rock fragments of gravel sizes, 1-3" or less.		8
Obstructions Flow Deflectors Sediment Traps	Rocks, old logs firmly embedded. Flow pattern of pool & riffles stable without cutting or deposition.	(2)	Some present, causing erosive cross currents and minor pool filling. Obstructions and deflectors newer and less firm.	(4) 3	Moderately frequent, moderately unstable obstructions & deflectors move with high water causing bank cutting and filling of pools.	(6)	Frequent obstructions and deflectors cause bank erosion yearlong. Sed. traps full, channel migration occuring.		8
Cutting	Little or none evident. Infrequent raw banks less than 6" high generally.	(4)	Some, intermittently at outcurves & constrictions. Raw banks may be up to 12".	(8) 6	Significant. Cuts 12"-24" high. Root mat overhangs and sloughing evident.	(12)	Almost continuous cuts, some over 24" high. Failure of overhangs frequent.		16
Deposition	Little or no enlargement of channel or point bars.	(4)	Some new increase in bar formation, most from coarse gravels.	(8) 5	Moderate deposition of new gravel & coarse sand on old and some new bars.	(12)	Extensive deposits of predominately fine particles. Accelerated bar development.		16
III. BOTTOM									
Rock Angularity	Sharp edges and corners, plane surfaces roughened.	(1)	Rounded corners & edges, surfaces smooth & flat.	(2)	Corners & edges well rounded in two dimensions.	(3)	Well rounded in all dimensions, surfaces smooth.		4
Brightness	Surfaces dull, darkened, or stained. Gen. not "bright".	(1)	Mostly dull but may have up to 35% bright surfaces.	(2)	Mixture, 50-50% dull and bright, ± 15%, ie 35-65%.	(3)	Predominately bright, 65% +, exposed or scoured surfaces.		4
Consolidation or Particle Packing	Assorted sizes tightly packed and/or overlapping.	(2)	Moderately packed with some overlapping.	(4)	Mostly a loose assortment with no apparent overlap.	(6)	No packing evident. Loose assortment, easily moved.		8
Bottom Size Distribution & Percent Stable Materials	No change in sizes evident. Stable materials 80-100%.	(4)	Distribution shift slight. Stable materials 50-80%.	(8)	Moderate change in sizes. Stable materials 20-50%.	9	Marked distribution change. Stable materials 0-20%.		16
Scouring and Deposition	Less than 5% of the bottom affected by scouring and deposition.	(6)	5-30% affected. Scour at constrictions and where grades steepen. Some deposition in pools.	(12)	30-50% affected. Deposits & scour at obstructions, constrictions, and bends. Some filling of pools.	(18) 13	More than 50% of the bottom in a state of flux or change nearly yearlong.		24
Clinging Aquatic Vegetation (Moss & Algae)	Abundant. Growth largely moss like, dark green, perennial. In swift water too.	(1)	Common. Algal forms in low velocity & pool areas. Moss here too and swifter waters.	(2)	Present but spotty, mostly in backwater areas. Seasonal blooms make rocks slick.	(3)	Perennial types scarce or absent. Yellow-green, short term bloom may be present.		4
	COLUMN TOTALS →	7	→	26	→	34	→	–	

Add the values in each column for a total reach score here. (E. 7 + G. 26 + F. 34 + P. – = 67).

Reach score of: <38=Excellent, 39-76=Good, 77-114=Fair, 115+=Poor.

R1-2500-5 (6

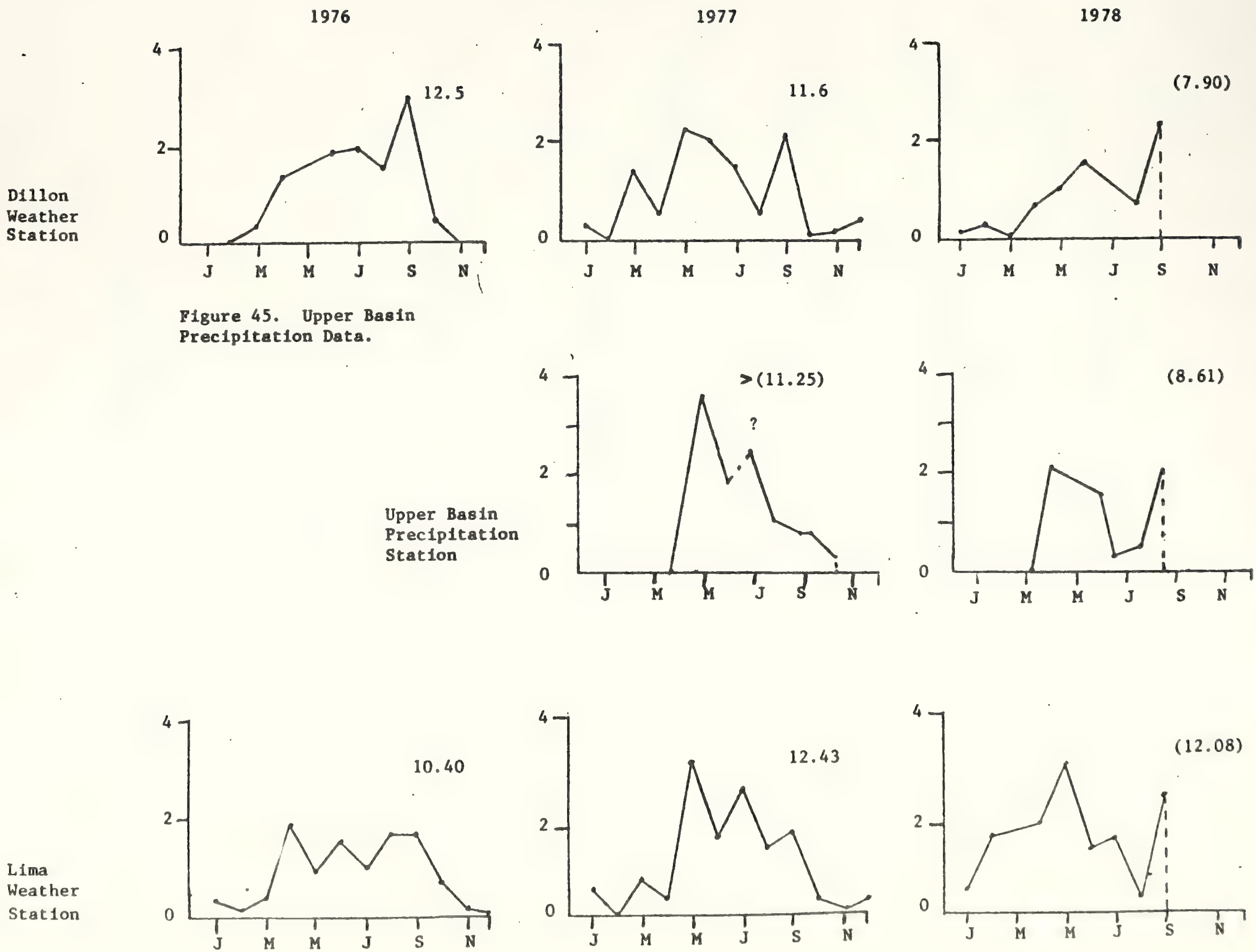


Figure 45. Upper Basin Precipitation Data.

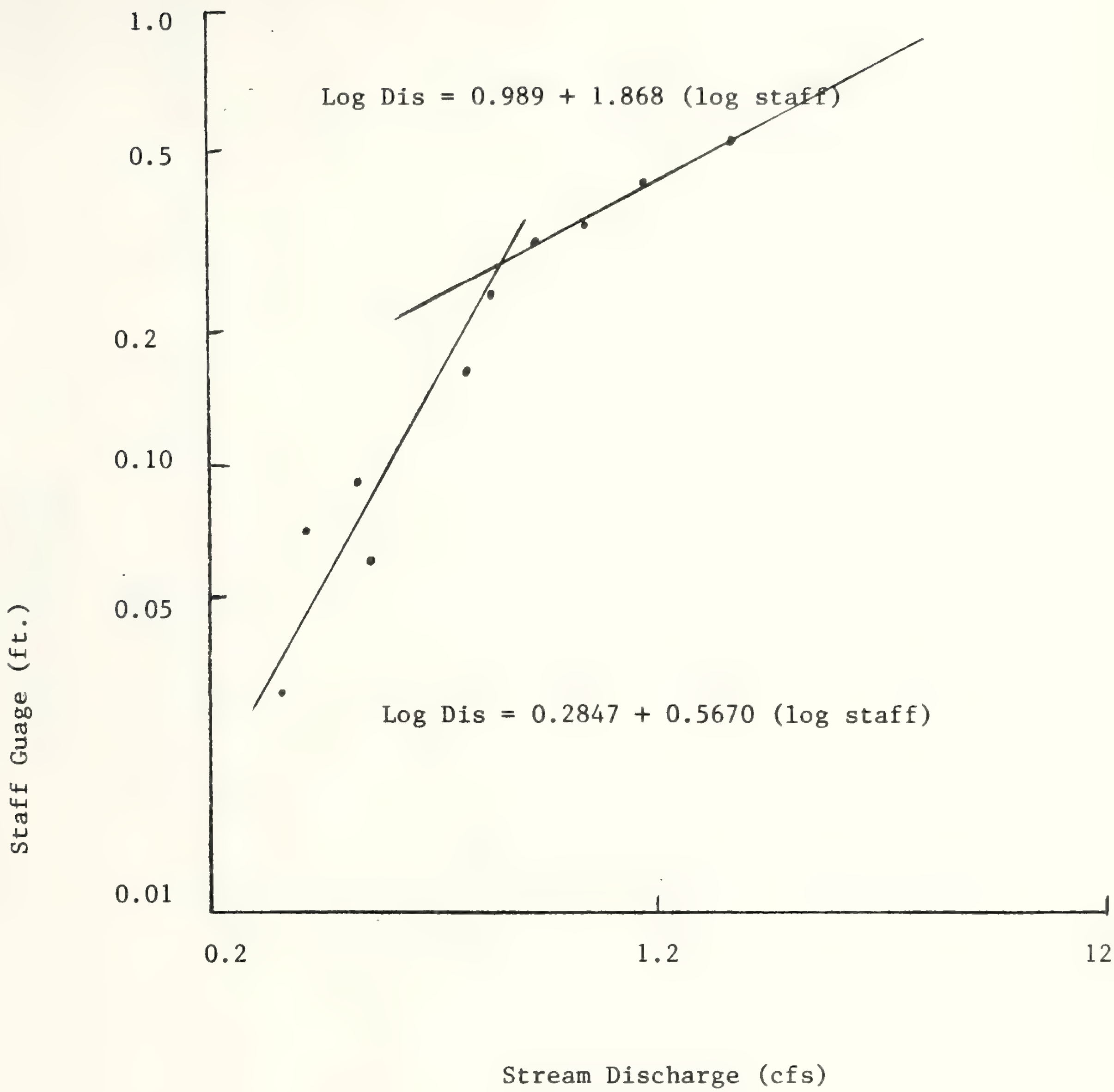


Figure 46. Staff-discharge Rating Curve for Lower Basin Sampling Station.

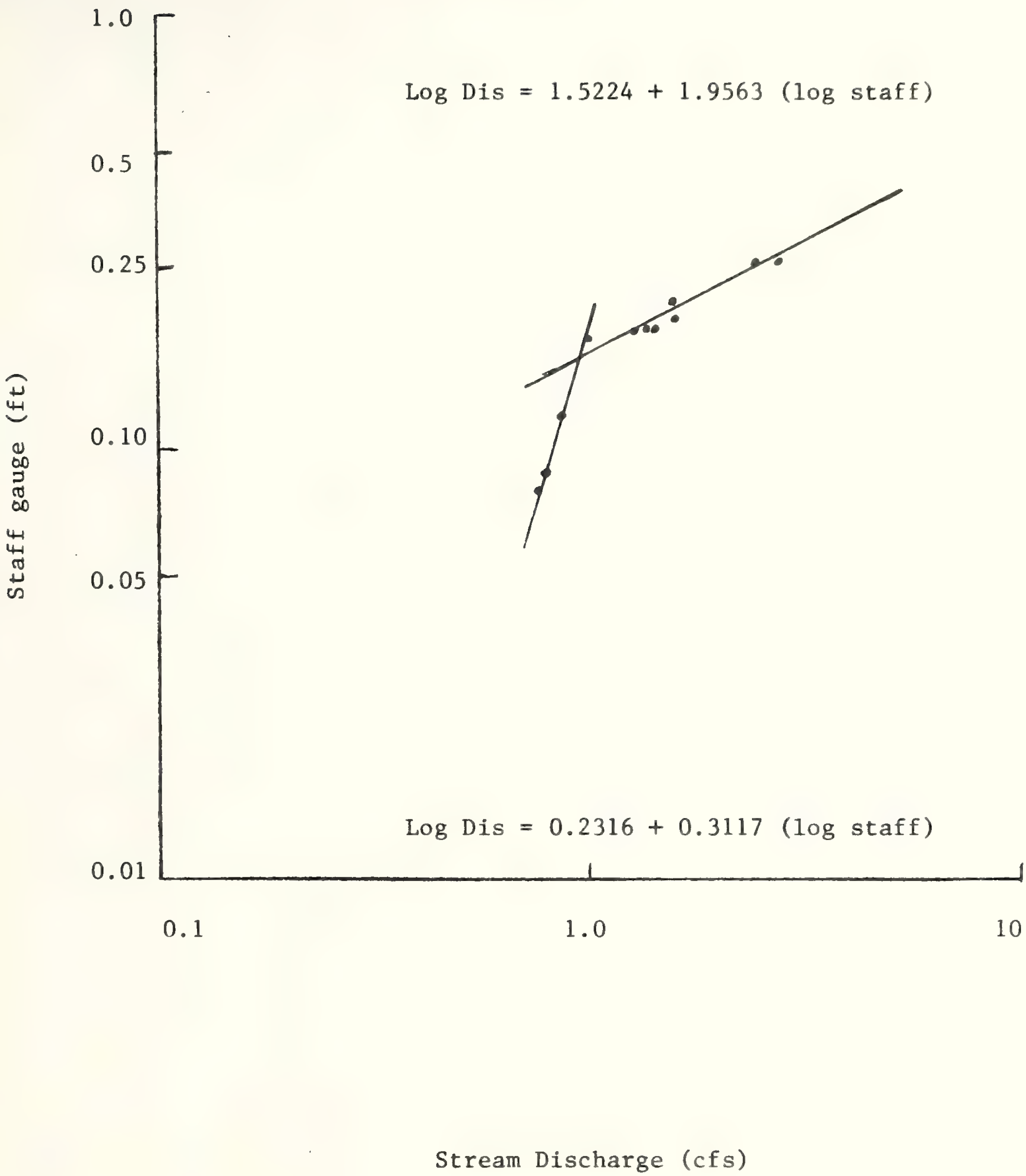


Figure 47. Staff-discharge Rating Curve for Upper Basin Sampling Station.

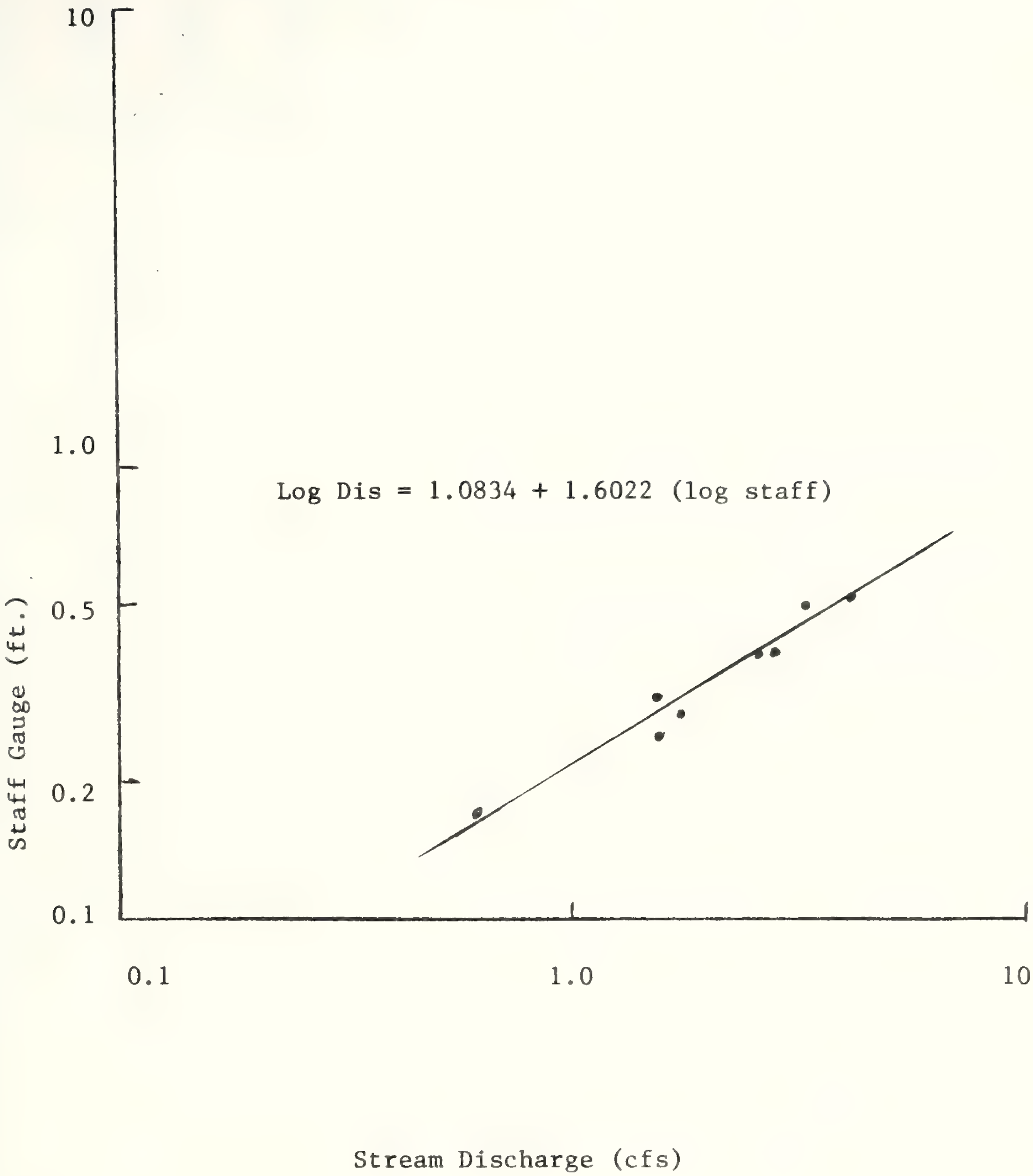


Figure 48. Staff-discharge Rating Curve for Little Basin Sampling Station.

FIGURE 49. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER BASIN - 1977

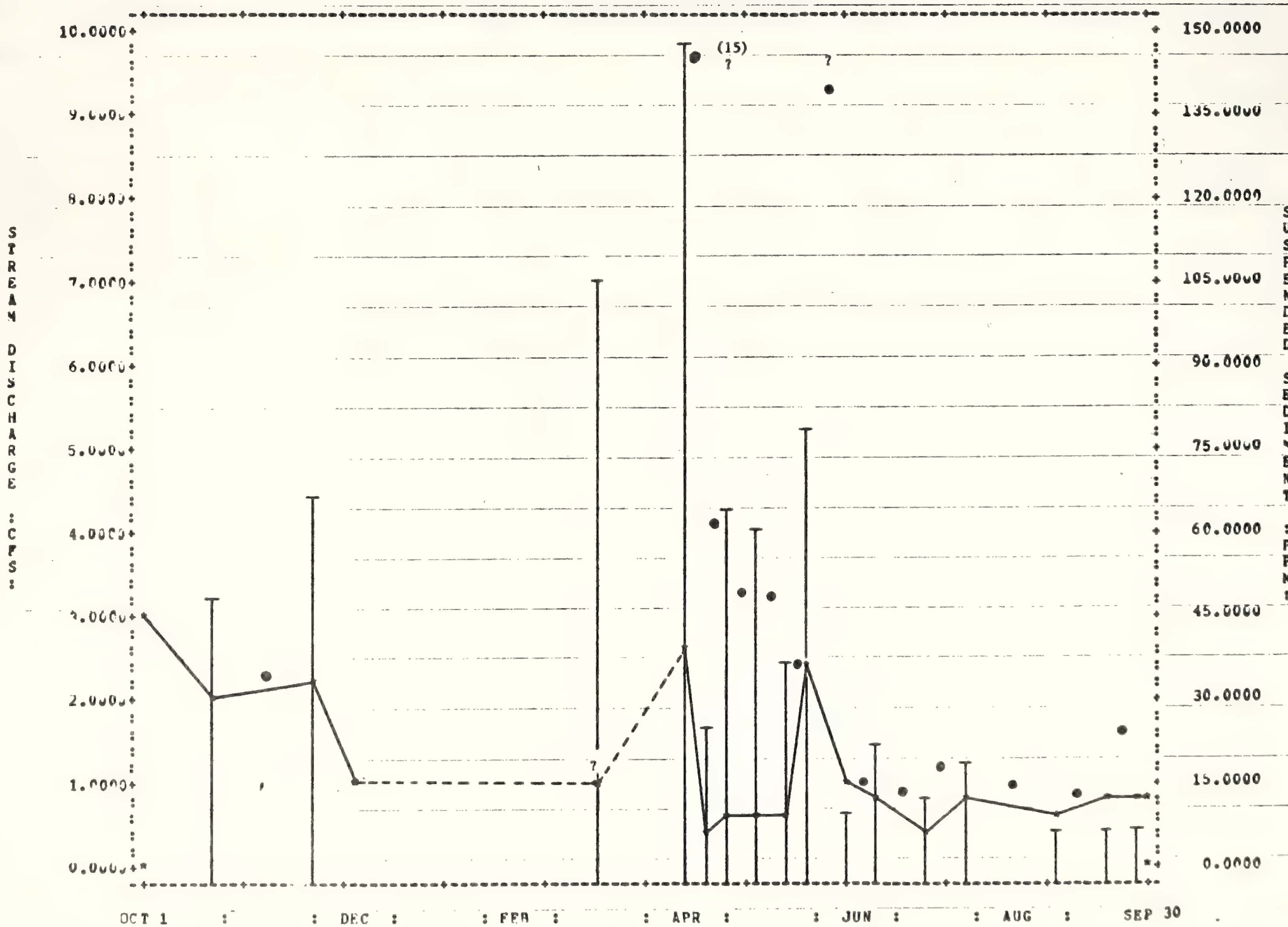


FIGURE 50. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LOWER BASIN - 1978

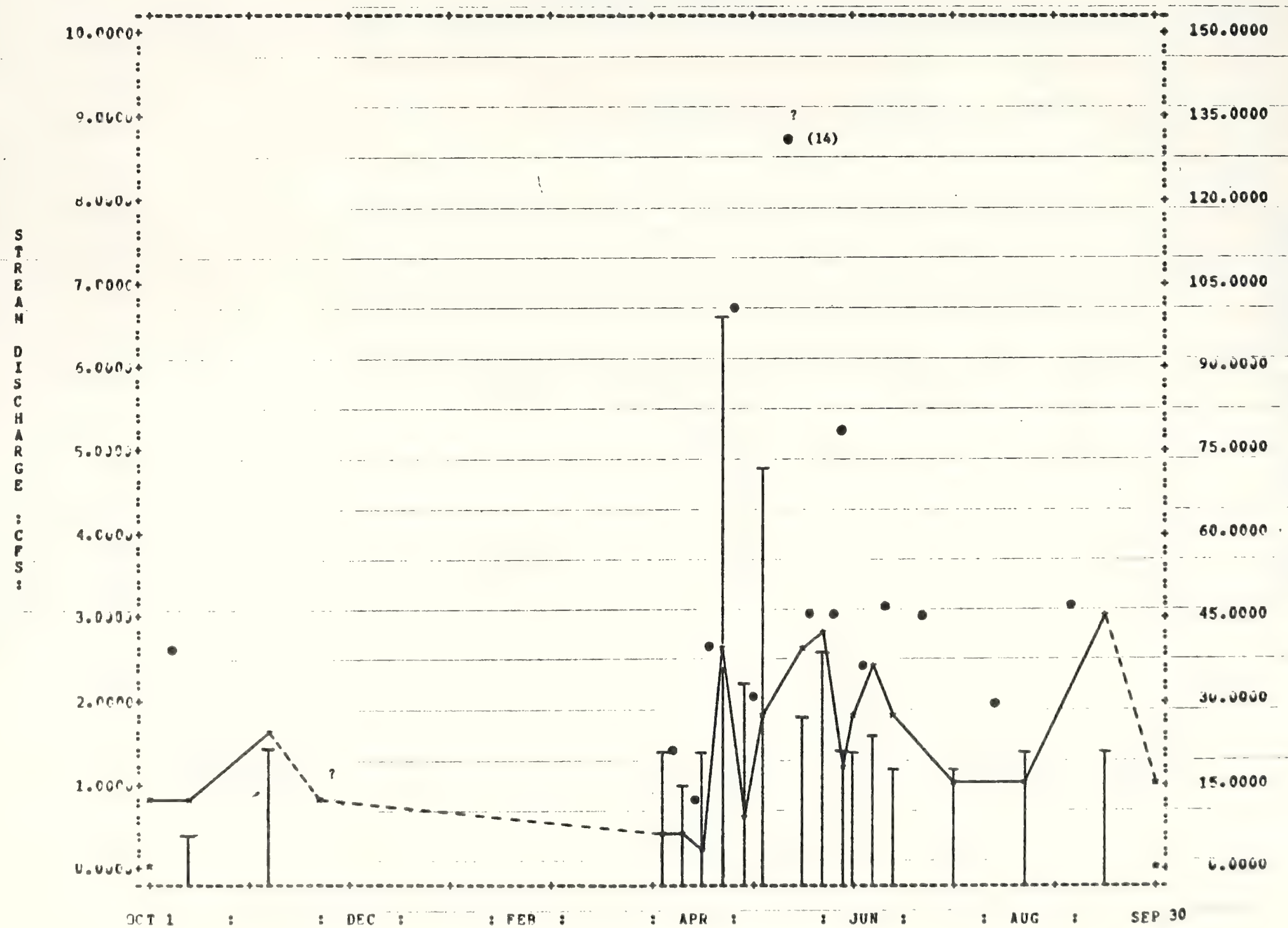


FIGURE 51. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER BASIN - 1977

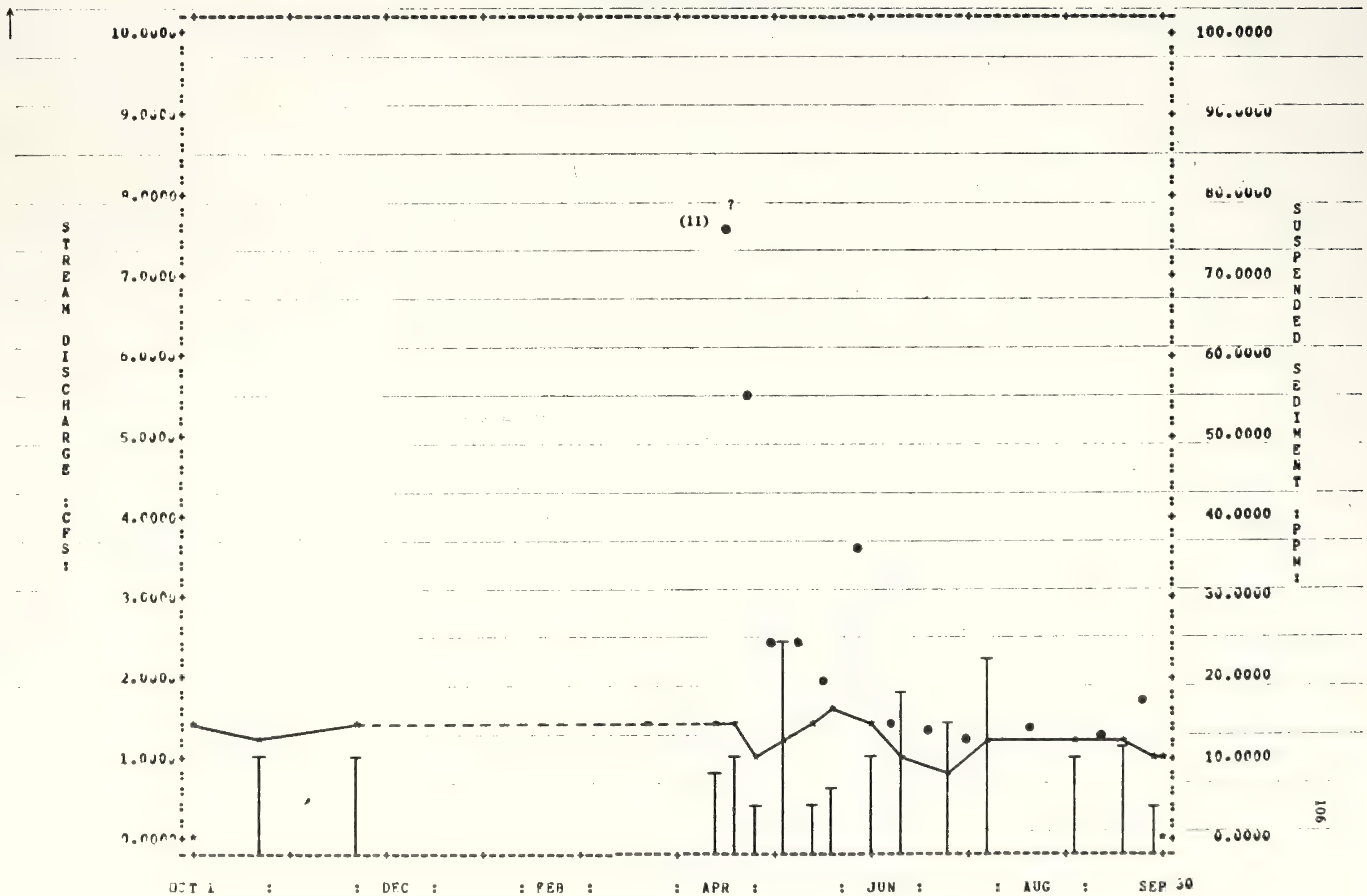


FIGURE 52. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

UPPER BASIN - 1978

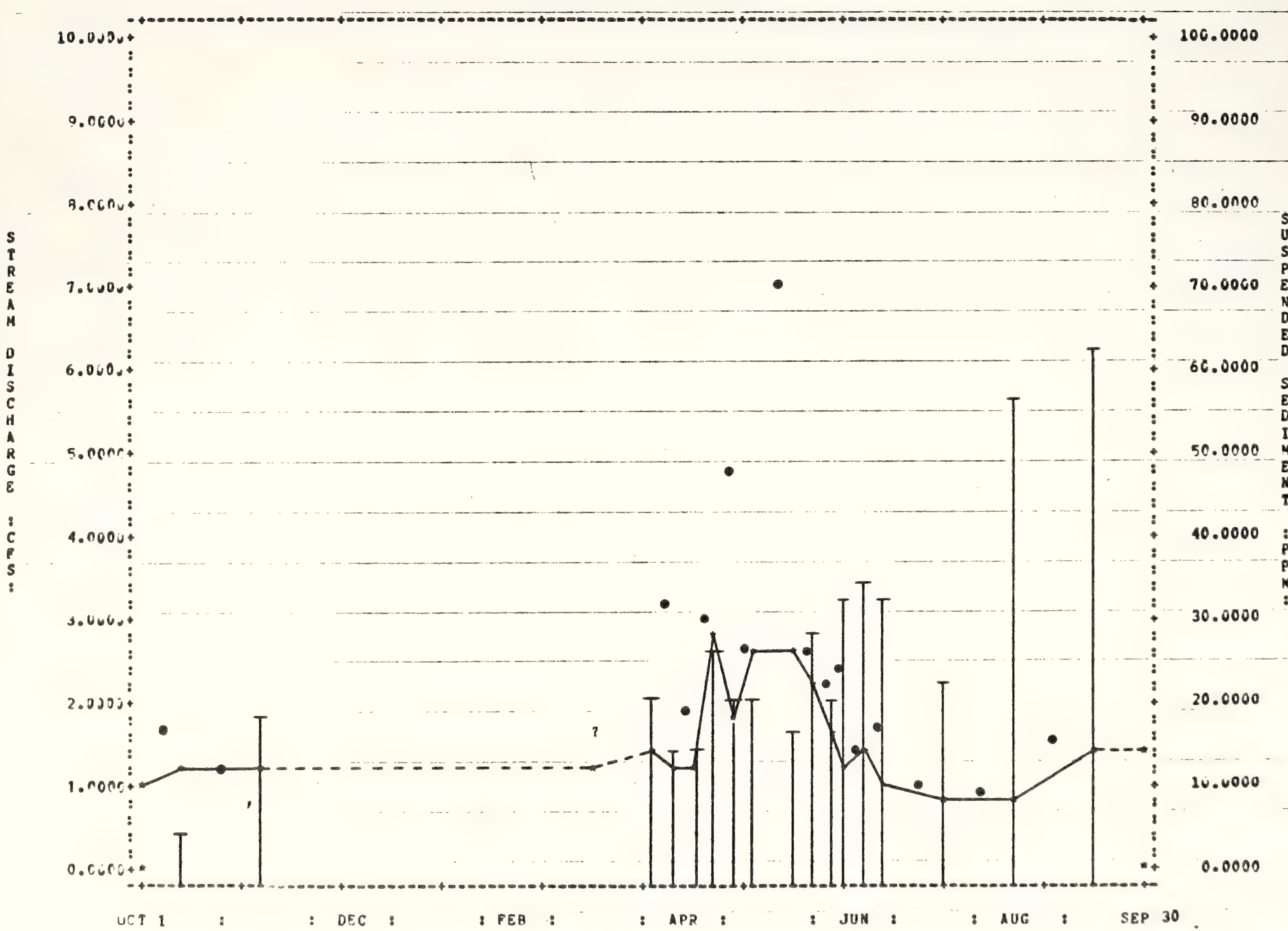


FIGURE 53. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LITTLE BASIN - 1977

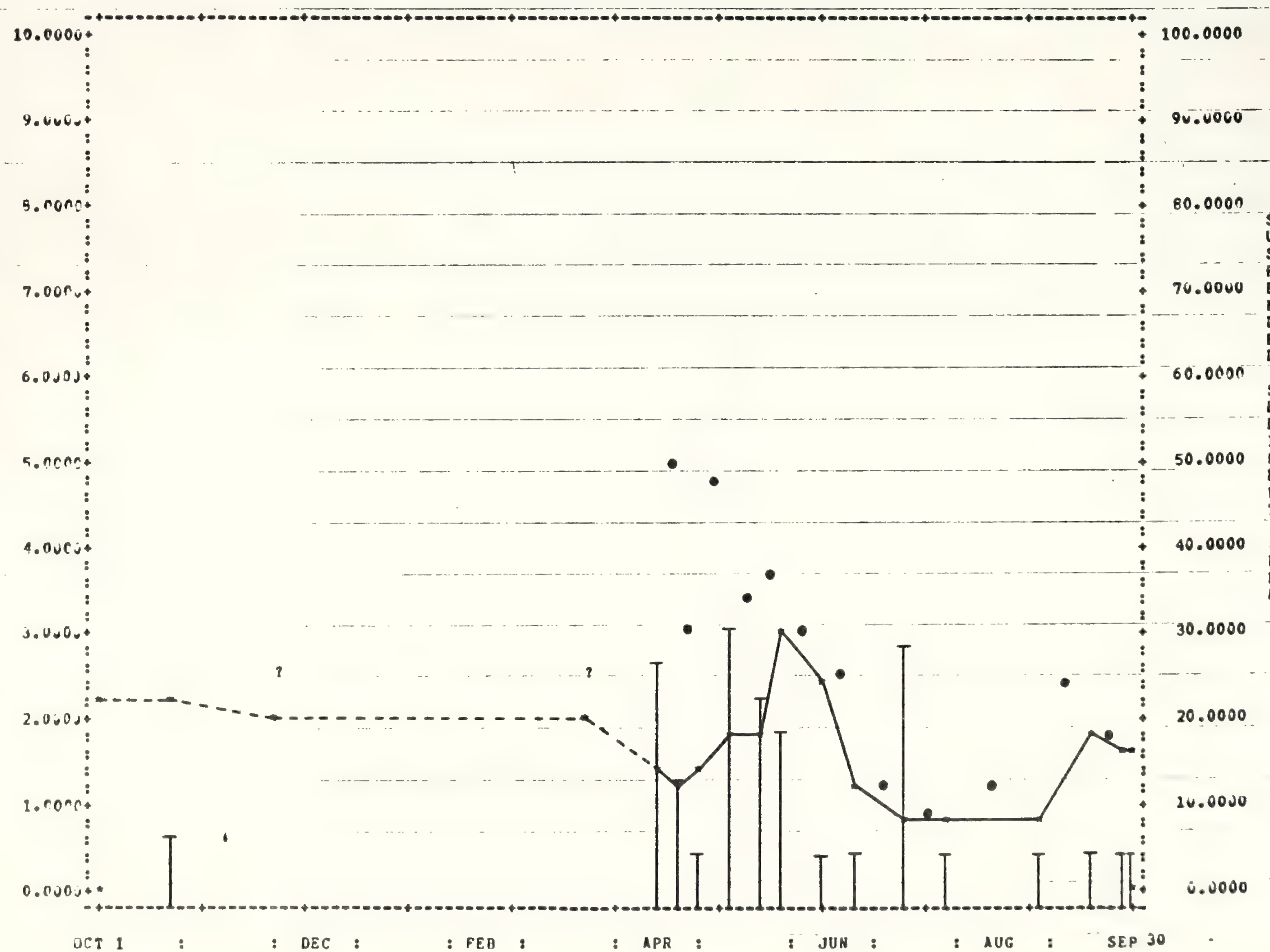
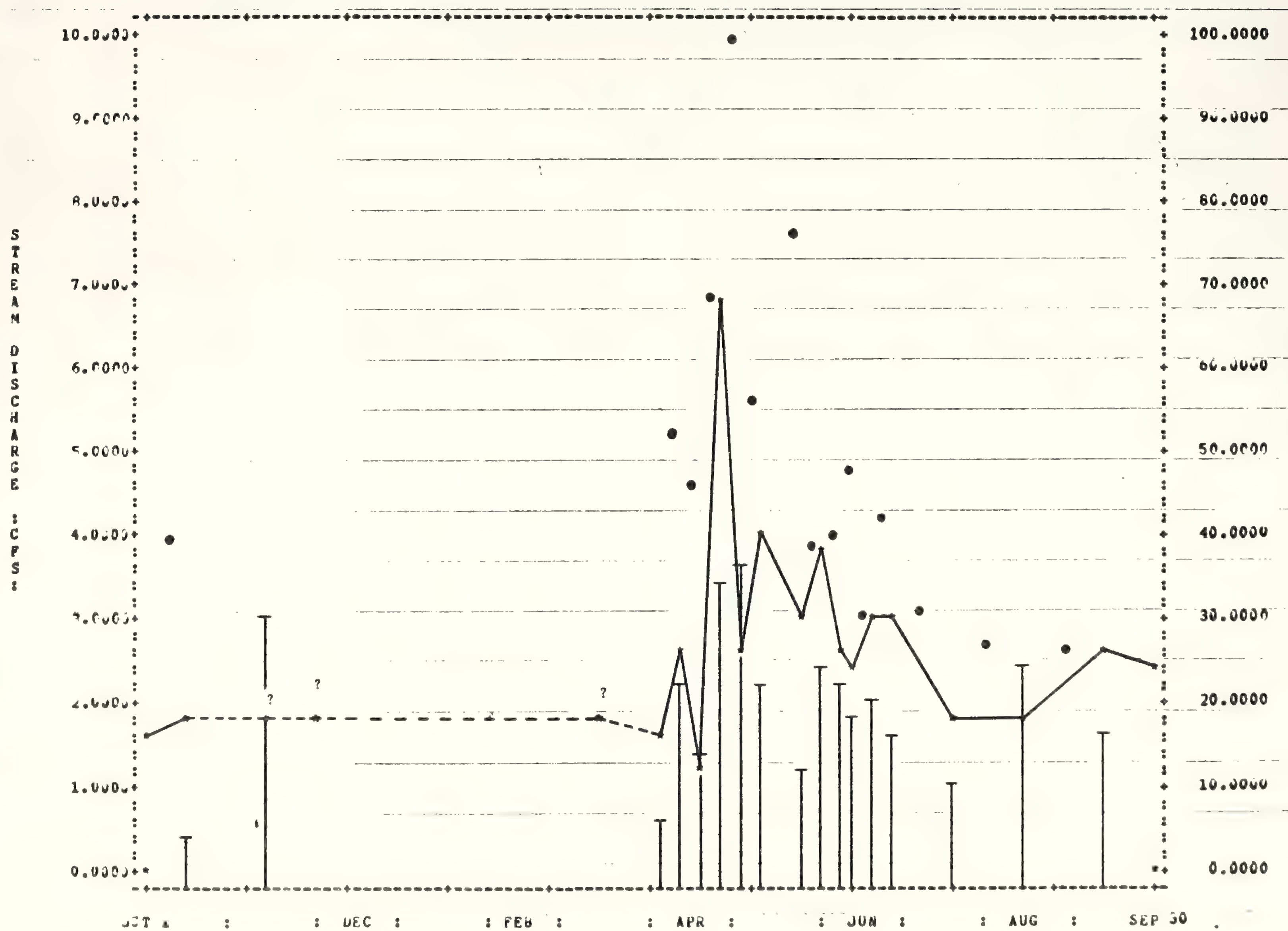


FIGURE 54. ANNUAL HYDROGRAPH AND SEDIMENT LOADINGS

LITTLE BASIN - 1978



in mid-May. The lowest recorded flow for 1978 was 0.26 cfs in mid-April. The Upper Basin station exhibited somewhat similar patterns. Residual channel ice may also have influenced an estimated peak dishcarge of 11 cfs in mid-April, 1977. The lowest recorded flow for the year was 0.88 cfs in mid-July. In 1978 an annual peak flow of 7.0 cfs was estimated for mid- to late May, while the lowest flow was recorded at 0.80 cfs in mid-July. Peak flow apparently occurred in mid-April, 1977 in Little Basin. Again, residual channel may have influenced the estimated 5.0 cfs crest stage figure. A secondary peak was noted for late May, while low flow for the year was 0.71 cfs in mid-July. An estimated 9.9 cfs peak occurred in early May, 1978, but was preceeded by the annual low flow of 1.3 cfs in mid-April. The differences noted in flow patterns for the two hydrologic years are largely attributed to differences in the annual precipitation patterns and to the influence of basin topography.

The respective annual hydrograph data were used to estimate the annual water yields for each station (Table 19). The Lower and Upper Basin stations approximated 1,000 acre feet each year, while Little Basin averaged nearly 1,500 acre feet. These estimates confirm general field observations. The reduced water yield for Lower Basin is attributed to evapotranspirational stress in and along the watercourse and to subsurface seepage of channel flow in the nearly flat terrain. In one instance a segment of Basin Creek above the Lower station was found dry. Absolute differences between the hydrologic years are difficult to determine owing to the high percentage of water yield that must be estimated for the winter months.

Suspended Sediment

The annual patterns of sediment concentration for each station by hydrologic year are depicted in Figures 49-54. Suspended sediment con-

Table 19. Estimated Water and Sediment Yields for Little Sage and Basin Sample Watersheds, 1977-1978

Station Name	Water Year	Estimated Water Yield (ac. - ft.)	Estimated Sediment Yield (tons)	Contributing Watershed (acres)	Runoff (in. / ac.)	Sediment Yield (lbs. / acre)
Little Sage	1977	780	31	14,720	0.64	4.19
	1978	780	21	14,720	0.64	2.85
Lower Basin	1977	1,150	61	32,960	0.42	3.70
	1978	890	33	32,960	0.32	2.00
Upper Basin	1977	940	15	6,720	1.68	4.34
	1978	950	33	6,720	1.70	9.71
Little Basin	1977	1,270	15	11,840	1.29	2.59
	1978	1,610	35	11,840	1.63	5.99

centrations at the Lower Basin station ranged from <5 ppm to 146 ppm, at Upper Basin from < 5 ppm to 63 ppm, and from < 5 ppm to 38 ppm for Little Basin. The relationships between suspended sediment and stream discharge for Lower Basin and Little Basin were statistically significant, but the relationship for Upper Basin was not (Figures 55-57). The variability in sediment concentration with stream flow is partially attributed to a seasonal effect, specific storm effects, the presence of cattle, and to the hysteresis effect, whereby peak concentrations of suspended sediment generally occur prior to peak runoff during the rising stage (Gregory and Walling, 1973, pp. 215-219). Annual sediment yields for the Basin stations were estimated from respective water yield and sediment concentration data (Table 19). The Lower station indicated a yield of 61 tons for 1977, but only 33 tons for 1978. Both Upper Basin and Little Basin generated 15 tons in 1977, which increased to 33 tons and 35 tons respectively for 1978.

Hydrochemical Parameters

The concentration of dissolved solids is inversely related to stream discharge so that lower concentrations occur during periods of high runoff, while higher concentrations are found during periods of low summer base flow (Gunnerson, 1967; Gregory and Walling, 1973, pp. 219-225). Patterns for specific ions, especially the ecologically important ones, often vary from this generalization (Likens, et al., 1977, pp. 74-76).

Specific conductance for the Lower Basin station ranged from a low of 272 μmhos to a high of 478 μmhos, Upper Basin from 242 μmhos to 363 μmhos, and Little Basin from 300 μmhos to 504 μmhos. The relationships between specific conductance and stream discharge for the Basin stations were statistically significant except for Upper Basin (Figures 58-60). Variation in specific conductance with stream discharge is partially attributed to

FIGURE 55. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LOWER BASIN

LOG SED = 1.3661 + 0.5018(LOG DIS)

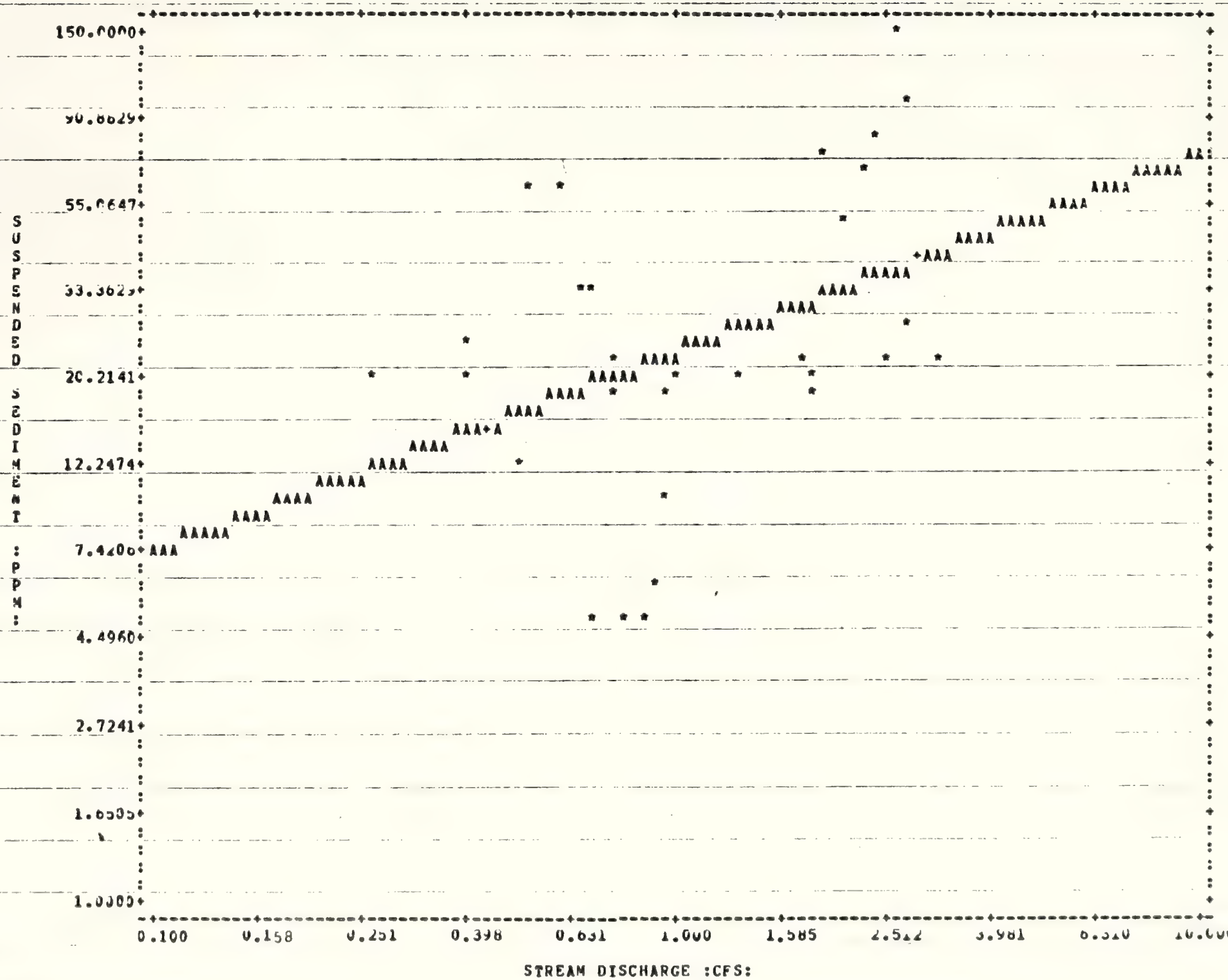


FIGURE 56. SUSPENDED SEDIMENT VS STREAM DISCHARGE - UPPER BASIN

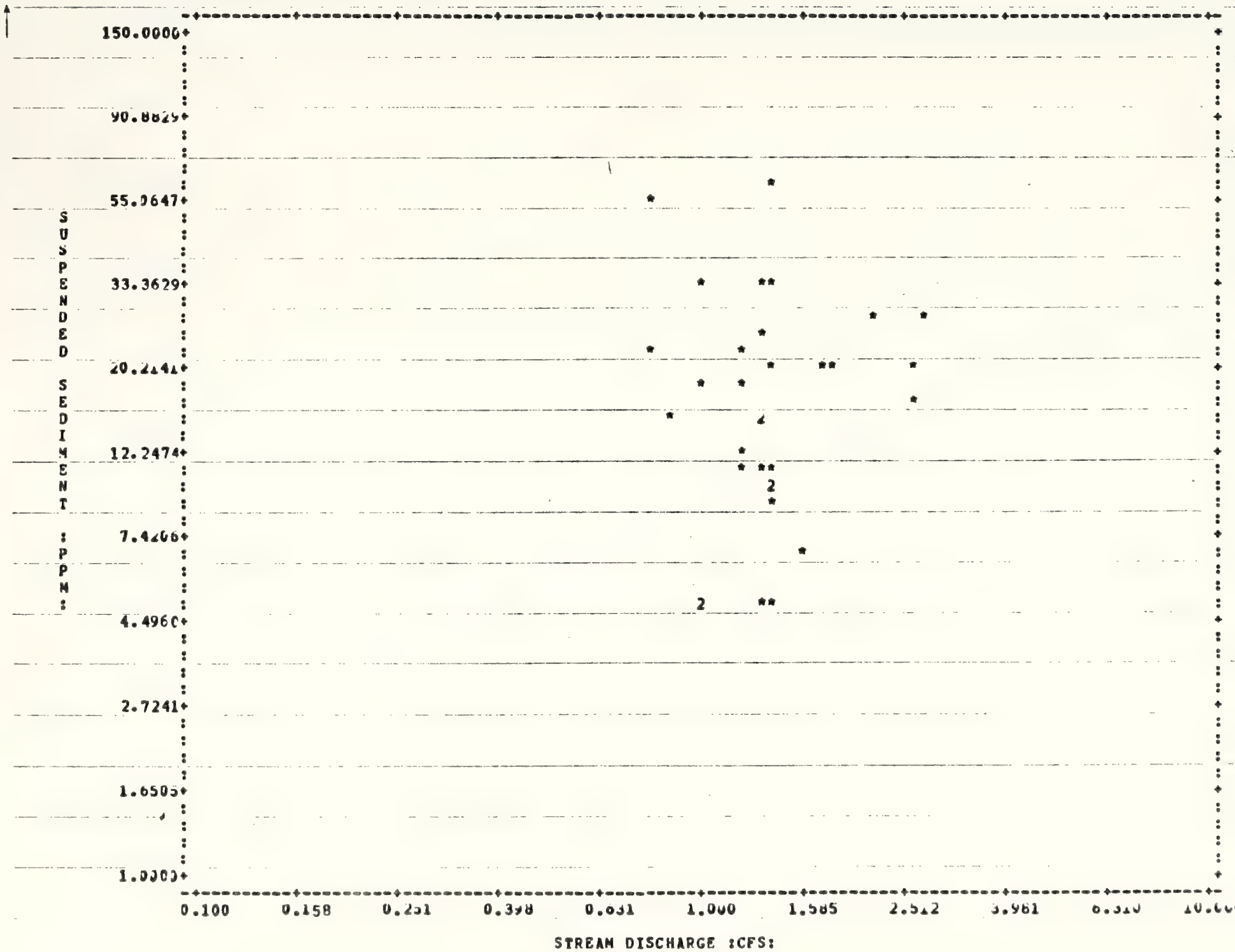


FIGURE 57. SUSPENDED SEDIMENT VS STREAM DISCHARGE - LITTLE BASIN

LOG SED = 0.9327 + 0.6177(LOG DIS)

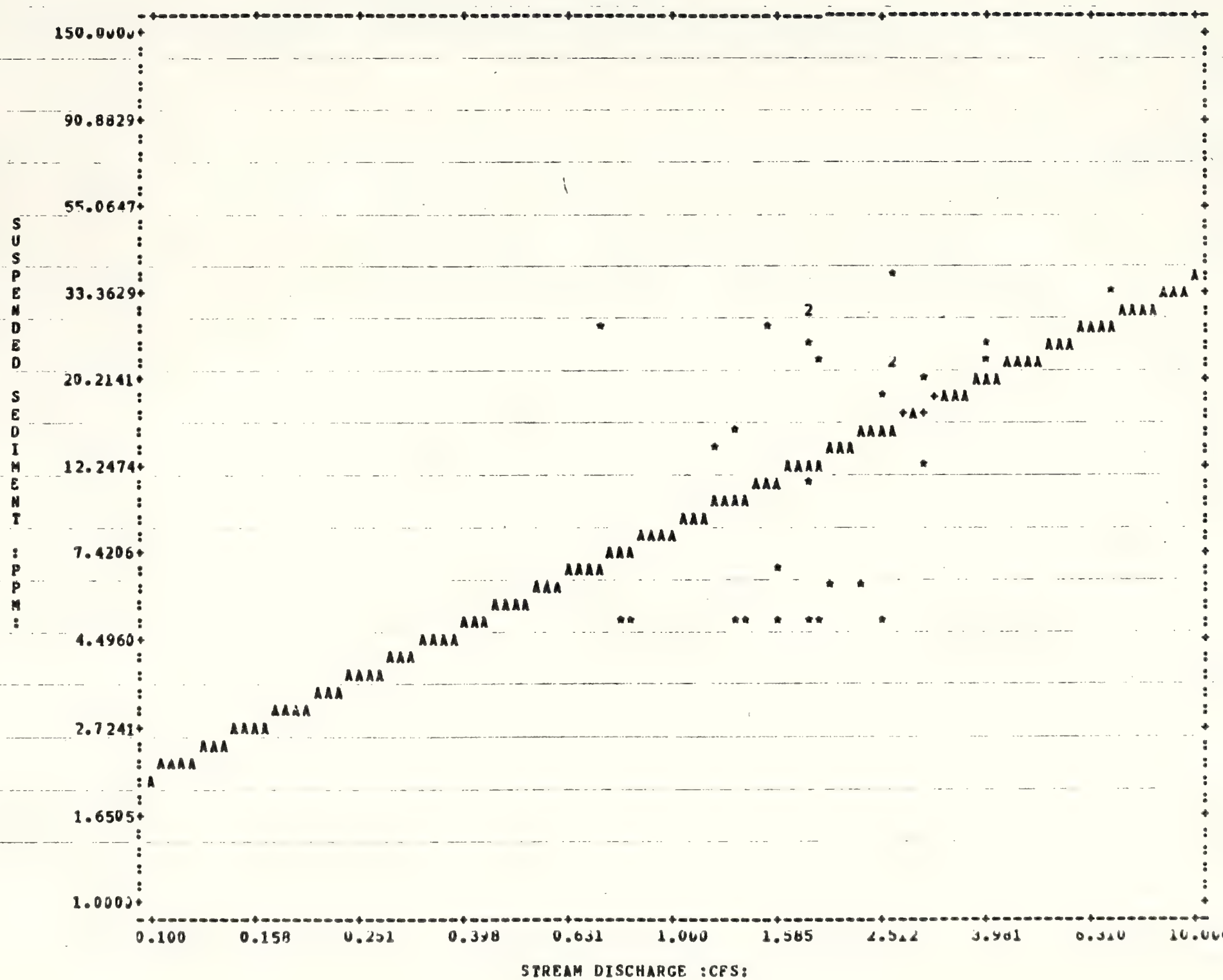


FIGURE 58. CONDUCTIVITY VS STREAM DISCHARGE - LOWER BASIN

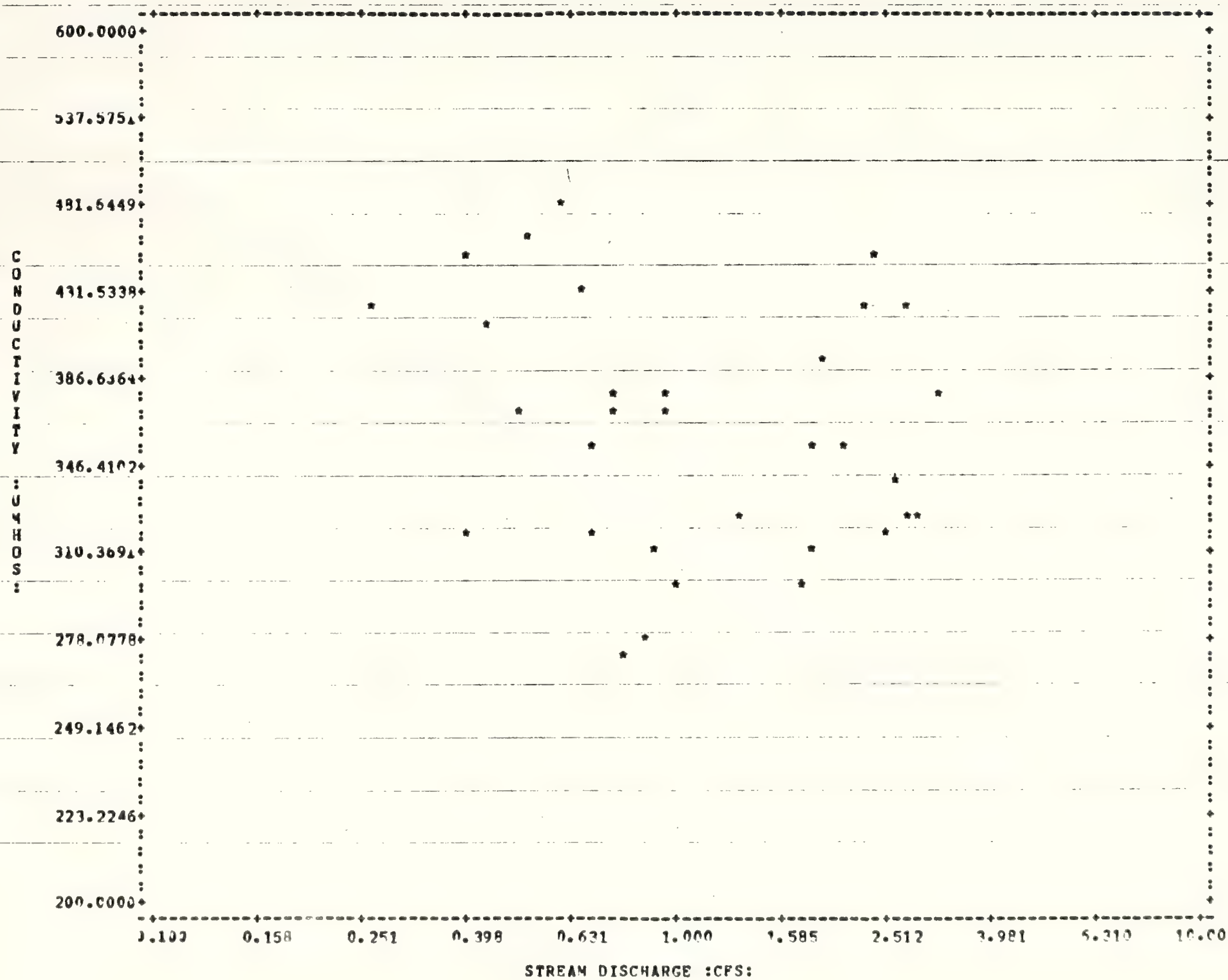


FIGURE 59. CONDUCTIVITY VS STREAM DISCHARGE - UPPER BASIN

LOG COND = 2.4904 - 0.2042(LOG DIS)

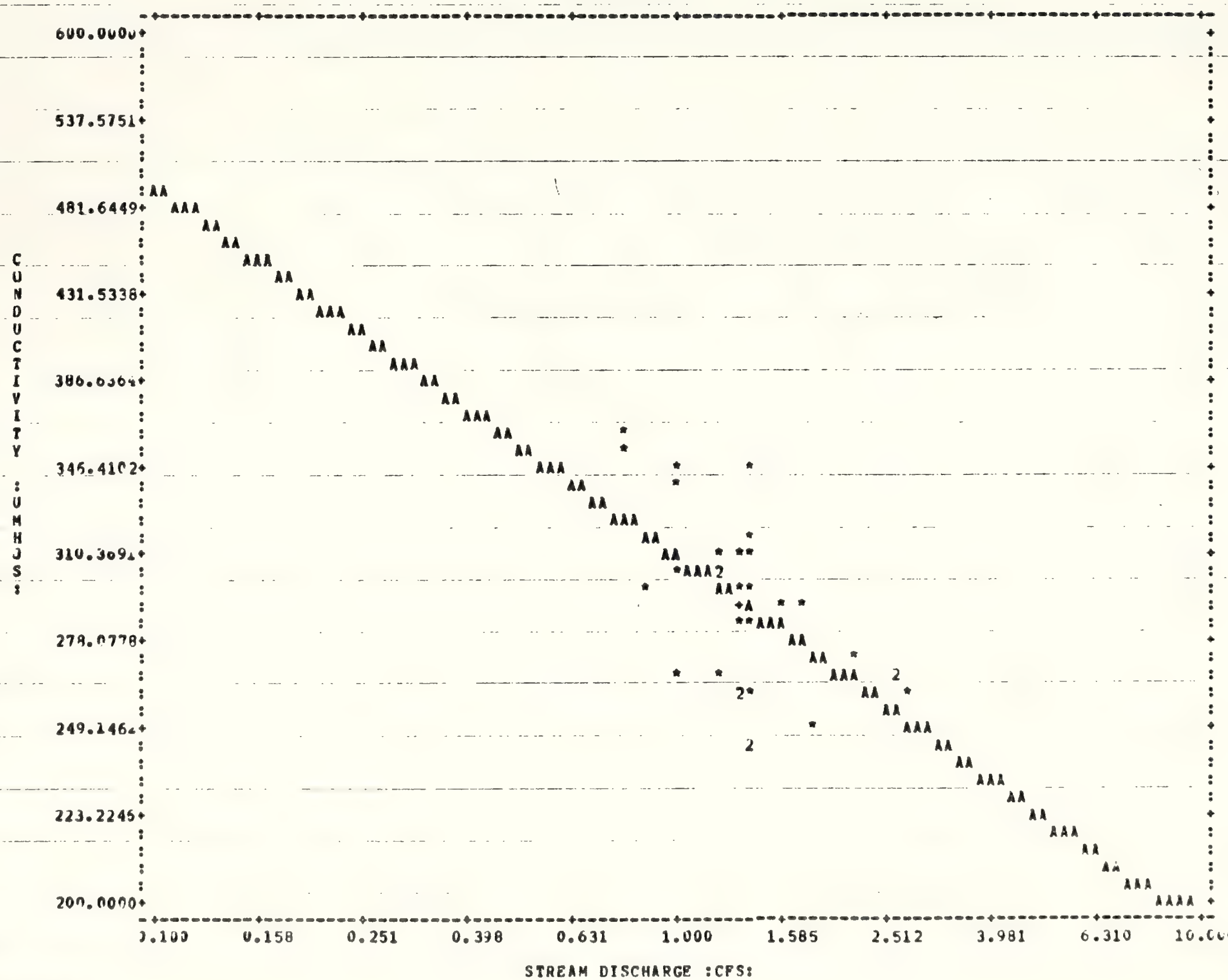
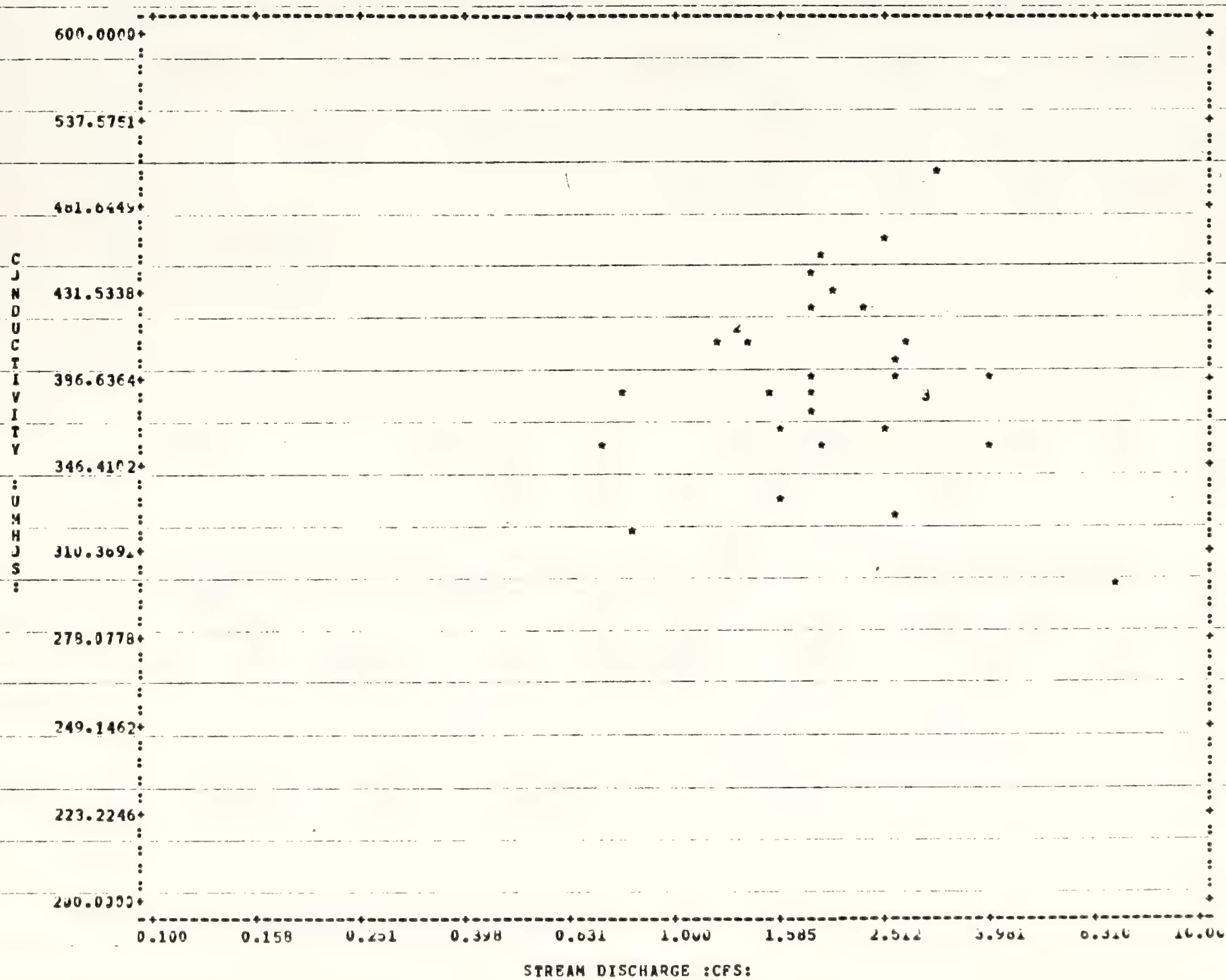


FIGURE 60. CONDUCTIVITY VS STREAM DISCHARGE - LITTLE BASIN



seasonal, and storm hysteresis effects (Gregory and Walling, 1973, pp. 219-225) and to the influence of topography. The ranges in ionic concentration for specific ions are presented in Table 20.

Bacteria Levels

The concentration of fecal and total coliforms in streams draining rangeland watersheds is directly related to the number of cattle present, their access to the stream, the physical and hydrological characteristics of the basin, local weather conditions (Kunkle, 1970; Stephensen and Street, 1978), and the time of day (Kunkle and Meiman, 1968). Seasonal patterns include a spring "flushing" effect during the rising stage (Kunkle and Meiman, 1978), with high counts during the low flow summer period, counts which often continue for some period after the cattle have been removed from the area (Stephensen and Street, 1978). This seasonal pattern may briefly be modified by local storms which produce their own "flushing" effect, and which may or may not be followed by a short term dilution period.

The concentrations of fecal coliform for the Basin Creek stations for the study period are presented in Table 21. Higher values occurred during the grazing season, especially with the known presence of livestock. Maximum fecal coliform levels were 490, 1,590 and 106 colonies/100 mls respectively for each station. Twenty-five percent each of the sample coliform counts for Lower and Upper Basin exceeded the 200 colony/100 ml limit of the Montana Water Quality Criteria. Little Basin had no exceptions. Low values were associated with the spring season.

Table 20 Ranges in Hydrochemical Parameters for Basin Creek, 1977 - 1978.

	Lower Basin	Upper Basin	Little Basin
pH	7.89 - 8.87	7.69 - 8.21	7.71 - 8.51
Alkalinity ($CaCO_3$)(mg/1)	139 - 217	134 - 185	149 - 230
Specific Conductance (umhos)	272 - 478	242 - 363	300 - 504
Total Dissolved Solids (mg/1)	177 - 311	157 - 236	183 - 328
Ca (mg/1)	(28) - 59	35 - 63	41 - 63
Mg (mg/1)	8.8 - 15	4.5 - 7.8	11 - 21
Na (mg/1)	6.8 - 13	3.6 - 7.0	5.3 - 15
K (mg/1)	2.6 - 6.3	2.0 - 4.3	.96 - 2.6
HCO_3 (mg/1)	165 - 265	164 - 226	172 - 281
SO_4	6 - 26	2 - 7	8 - 34
NH_4 (mg/1)	$<$.01 - .09	$<$.01 - .08	$<$.01 - .18
NO_2 + NO_3 - N (mg/1)	$<$.01 - .31	$<$.01 - (.19)	$<$.01 - .09
PO_4 (Ortho) - P (mg/1)	$<$.001 - (.120)	.004 - (.139)	T - .034

Table 21 Fecal Coliform Counts (colonies/100 mls) for Basin Creek, 1977 - 1978.

	Lower Basin		Upper Basin		Little Basin	
	1977	1978	1977	1978	1977	1978
April		--		--		--
May	<1	<2	<1	1		<2
June	7(?)	20	4(?)	2	2(?)	6
July	120(?)	27	83(?)	161(?)	2(?)	106(?)
August	24*	15(?)	245(?)	1260*	7(?)	30(?)
September	490*	307(?)	22(?)	1590*	6(?)	43(?)
October	230*		68*		2(?)	
November	8*		25(?)		<2(?)	

* Stock visually present.

(?) Stock presence uncertain.

Comments

Basin Creek, especially the middle portion, is a very gentle, high elevation, dryland basin. This suite of environmental conditions may retard the normal annual flushing effect encountered in other environments. Thus, neither suspended sediment concentration nor conductivity was strongly correlated with stream discharge within the general basin. In addition, there is some indication that livestock influenced sediment concentrations on several occasions. Because of the limited number of samples taken and the nature of the hydrochemical parameters evaluated. relationships between the water quality characteristics of Basin Creek and the Montana Water Quality Criteria cannot be addressed.

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BASIC DATA RECORD

Station: Lower Blacktail
Location: S 28 T 11S R 5W
Water Year: 1977

Stream Reach Score: 65
Survey Date: 8/15/76

	1976 9/23	10/25	11/20	1977 5/2	5/12	5/19	5/31	6/13	6/25
Date	9/23	10/25	11/20	5/2	5/12	5/19	5/31	6/13	6/25
Time		1230	1130	1215	1230	1430	1200	1230	1130
Temperature (F°)									
air		36	30	50	61	43	64	57	70
water		34	36	44	45	44	45	45	50
water (max)	inst	46		inst	47	46	lost	inst	lost
water (min)	inst	34		inst	36	34	lost	inst	lost
Precipitation (in)									
Discharge (cfs)									
instant	24	21	19	29	25	28	38	195*	76
crest stage				set	45	76	38	> 195	220
Suspended									
sediment (ppm)		14	28	12	31	21	16	117	29
Chemical Character									
PH				8.13			8.14		7.95
ALK ($CaCO_3$) (mg/l)				130			160		156
SC (µmhos)		363	362	274	328	333	335	272	321
TDS (mg/l)		235	235	178	213	216	218	177	209
Ca "				43			49		47
Mg "				10			12		11
Na "				3.0			3.7		3.2
K "				1.1			0.97		0.78
HCO_3 "				159			195		190
SO_4 "				21			23		17
NH_4 "				--			--		< .01
NO_2 & NO_3 -N "				--			< .01		.17
PO_4 (Ortho)-P "				--			.002		.005
Biological Character									
Total Coliform (colonies/100 mls)							< 1		< 1
Fecal Coliform (colonies/100 mls)							< 1		1
Stock present									n

Legend:
- set - Initial settings of instrument
- inst - Installation of ppt gages
- T - Trace or Trickle
- Moved - Station was moved to a beter location
- ( ) - Value questionable
- TNTC - Too numerous to count
- u - Unknown
- y - yes
- n - no
- ice - Station was iced so that sample variable was not obtainable

*Staff dislodged

BASIC DATA RECORD

Station: Lower Blacktail
Location: S 28 T 11S R 5W
Water Year: 1977

Stream Reach Score: 65
Survey Date: 8/15/76

Date	7/13	7/29	8/32	9/22	9/30
Time	1245	1315	1145	1300	1315
Temperature (F°)					
air	59	68	54	41	36
water	51	54	45	42	38
water (max)	inst	59	58	55	49
water (min)	inst	41	40	37	36
Precipitation (in)					
Discharge (cfs)					
instant	32	30*	27	24	18**
crest stage	76	≥ 32	30	27	25
Suspended sediment (ppm)	15	5	10	< 5	13
Chemical Character					
PH		8.22	8.13		8.10
ALK ($CaCO_3$) (mg/l)		161	163		151
SC (µmhos)	298	308	313	330	303
TDS (mg/l)	194	200	203	214	197
Ca "		48	54		56
Mg "		13	15		16
Na "		3.8	4.5		4.8
K "		0.86	1.1		1.1
HCO_3 "		196	199		184
SO_4 "		24	28		26
NH_4 "		--	.01		.06
NO_2 & NO_3 -N "		.03	.17		.11
PO_4 (Ortho)-P "		.010	T		.013
Biological Character					
Total Coliform (colonies/100 mls)		54	30		4
Fecal Coliform (colonies/100 mls)		51	40		8
Stock present	n	y	y	y	n

* Staff dislodged
** Staff moved

BASIC DATA RECORD

Station: Lower Blacktail

Location: S 28 T 11S R 5W

Water Year: 1978

Stream Reach Score: 65

Survey Date: 8/15/76

	1977		1978						
Date	10/18	11/12	5/24	5/31	6/4	6/9	6/16	6/20	6/28
Time	1300	1700	1730	1045	1730	2000	1315	1830	1300
Temperature (F°)									
air	64	34	37	37	66	59	59	62	78
water	41	36	41	35	49	43	44	49	48
water (max)	47	46			inst	47	44		
water (min)	32	32			inst	40	40		
Precipitation (in)									
Discharge (cfs)									
instant	12	12	98	83	91	338	214	168	117
crest stage	18	45	set	98	91	338	430	267	176
Suspended sediment (ppm)	12	--	97	31	75	670	69	54	38
Chemical Character									
PH	8.10	8.10	8.00					8.09	
ALK ($CaCO_3$) (mg/l)	165	147	145					131	
SC (μmhos)	329	312	277	295	283	208	261	272	316
TDS (mg/l)	214	203	180	192	184	135	170	177	205
Ca "	52	48	41					41	
Mg "	16	14	10					9.7	
Na "	4.4	3.9	3.4					3.1	
K "	0.95	0.81	1.3					0.72	
HCO_3 "	202	180	175					158	
SO_4 "	26	25	10					5	
NH_4 "	.14	.02	.02					.01	
NO_2 & NO_3 -N "	.09	.15	.02					.02	
PO_4 (Ortho)-P "	.055	T	.019					.030	
Biological Character									
Total Coliform (colonies/100 mls)	15	10	275					240	
Fecal Coliform (colonies/100 mls)	4	2	2					< 2	
Stock present	n	n	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Lower Blacktail
Location: S 28 T 11S R 5W
Water Year: 1978

Stream Reach Score: 65

Survey Date: 8/15/76

Date	7/6	7/18	8/17	9/15
Time	1415	1300	1330	
Temperature (F°)				
air	60	62	44	57
water	47	49	43	46
water (max)	55	57	60	54
water (min)	41	41	39	37
Precipitation (in)				
Discharge (cfs)				
instant	87	58	30	24
crest stage	154	96	58	39
Suspended sediment (ppm)	22	23	34	21
Chemical Character				
PH		8.28	8.09	8.25
ALK ($CaCO_3$) (mg/l)		160	142	150
SC (μmhos)	320	342	355	359
TDS (mg/l)	208	222	231	233
Ca "		46	45	41
Mg "		11	13	14
Na "		3.2	3.8	4.1
K "		0.79	0.89	1.3
HCO_3 "		196	173	138
SO_4 "		23	26	28
NH_4 "		.02	.01	< .01
NO_2 & NO_3 -N "		.03	.04	.04
PO_4 (Ortho)-P "		.015	.016	.010
Biological Character				
Total Coliform (colonies/100 mls)		927	1040	2830
Fecal Coliform (colonies/100 mls)		< 1	27	3
Stock present	n	n	y	y

BASIC DATA RECORD

Station: Upper Blacktail

Location: S 35 T 11S R 5W

Water Year: 1977

Stream Reach Score: 77

Survey Date: 8/15/76

	1976			1977					
Date	9/22	10/25	11/20	5/2	5/12	5/19	5/31	6/13	6/25
Time		1045	0945	1145	1045	1130	1030	1030	0900
Temperature (F°)									
air		32	28	46	59	38	59	59	64
water		34	36	41	42	39	41	42	46
water (max)	inst	46		inst	50	51	49	inst	55
water (min)	inst	34		inst	32	39	34	inst	37
Precipitation (in)					inst	1.48	1.70	4.19	1.02
Discharge (cfs)									
instant	16	14	13	21	15	18	24	149	53
crest stage		set	17	set	28	47	55	167	151
Suspended sediment (ppm)		< 5	38	7	36	13	16	111	24
Chemical Character									
PH				8.01			8.05		7.88
ALK ($CaCO_3$) (mg/l)				121			159		154
SC (μmhos)		357	368	248	325	326	227	252	305
TDS (mg/l)		232	239	161	211	212	213	164	195
Ca "				41			49		46
Mg "				8.6			11		7.8
Na "				3.0			3.9		3.3
K "				1.0			0.87		0.72
HCO_3 "				148			194		188
SO_4 "				15			17		15
NH_4 "				--			--		< .01
NO_2 & NO_3 -N "				--			.10		.04
PO_4 (Ortho)-P "				--			.002		.005
Biological Character									
Total Coliform (colonies/100 mls)							< 1		< 1
Fecal Coliform (colonies/100 mls)							< 1		1
Stock present									n

BASIC DATA RECORD

Station: Upper Blacktail
Location: S 35 T 11S R 5W
Water Year: 1977

Stream Reach Score: 77

Survey Date: 8/15/76

Date	7/13	7/29	8/32	9/22	9/30
Time	1100	1200	1015	1030	1145
Temperature (F°)					
air	56	64	47	36	32
water	48	50	44	39	36
water (max)	56	61	57	55	48
water (min)	38	41	37	37	36
Precipitation (in)	1.07	1.71	2.51	2.29	1.49
Discharge (cfs)					
instant	27	21	18	16	17
crest stage	54	27	24	30	18
Suspended sediment (ppm)	12	< 5	9	< 5	< 5
Chemical Character					
PH		8.09	7.76		7.90
ALK ($CaCO_3$) (mg/l)		164	168		151
SC (µmhos)	285	297	302	330	296
TDS (mg/l)	185	193	196	214	193
Ca "		51	54		55
Mg "		12	14		14
Na "		4.2	5.0		5.1
K "		0.84	0.94		1.0
HCO_3 "		200	205		184
SO_4 "		20	22		23
NH_4 "		--	< .01		.02
NO_2 & NO_3 -N "		.06	.15		.13
PO_4 (Ortho)-P "		.012	T		.008
Biological Character					
Total Coliform (colonies/100 mls)		< 2	2		10
Fecal Coliform (colonies/100 mls)		3	2		4
Stock present	n	n	n	n	n

BASIC DATA RECORD

Station: Upper Blacktail
Location: S 35 T 11S R 5W
Water Year: 1978

Stream Reach Score: 77
Survey Date: 8/15/76

	1977		1978					
Date	10/18	11/12	5/24	6/4	6/9	6/16	6/20	6/28
Time	1130	1500	1530	1400	1800	1115	1645	1130
Temperature (F°)								
air	57	32	44	59	55	48	64	66
water	40	37	39	45	41	36	46	44
water (max)	46	46		inst	46	43	46	50
water (min)	35	34		inst	34	34	36	37
Precipitation (in)	0.67	0.64		inst	0.00	1.17	0.33	> 0.42
Discharge (cfs)								
instant	16	13	73	66	266	158	128	88
crest stage	27	17	set	73	266	275	158	148
Suspended sediment (ppm)	8	17	48	34	585	58	53	24
Chemical Character								
PH	7.92	7.91	8.00				8.01	
ALK ($CaCO_3$) (mg/l)	178	148	149				145	
SC (µmhos)	332	297	270	275	190	245	259	301
TDS (mg/l)	216	193	176	179	124	159	168	196
Ca "	55	53	39				40	
Mg "	15	13	9.3				8.9	
Na "	4.9	2.7	3.4				3.3	
K "	0.93	0.70	0.82				0.81	
HCO_3 "	218	181	180				174	
SO_4 "	24	19	8				4	
NH_4 "	.11	< .01	.20				(.44)	
NO_2 & NO_3 -N "	.14	.15	.05				.03	
PO_4 (Ortho)-P "	.006	.002	.021				.048	
Biological Character								
Total Coliform (colonies/100 mls)	15	< 2	744				170	
Fecal Coliform (colonies/100 mls)	< 4	1	< 1				3	
Stock present	n	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Upper Blacktail
Location: S 35 T 11S R 5W
Water Year: 1978

Stream Reach Score: 77
Survey Date: 8/15/76

Date	7/6	7/18	8/17	9/15
Time	1415	1115	1100	1100
Temperature (F°)				
air	54	59	37	51
water	44	44	39	39
water (max)	51	55	55	52
water (min)	37	39	37	34
Precipitation (in)	0.53	0.77	1.28	3.88
Discharge (cfs)				
instant	67	39	20	16
crest stage	111	67	39	20
Suspended sediment (ppm)	17	20	24	23
Chemical Character				
PH		8.23	7.96	8.07
ALK ($CaCO_3$) (mg/l)		158	145	141
SC (μmhos)	316	320	348	352
TDS (mg/l)	205	208	226	229
Ca "		44	46	43
Mg "		11	12	12
Na "		3.3	3.7	4.6
K "		0.77	0.72	1.1
HCO_3 "		193	177	171
SO_4 "		22	26	25
NH_4 "		<.01	.01	.01
NO_2 & NO_3 -N "		.05	.04	.02
PO_4 (Ortho)-P "		.017	.016	.011
Biological Character				
Total Coliform (colonies/100 mls)		197	23	417
Fecal Coliform (colonies/100 mls)		3	<1	1
Stock present	n	n	y	y

BASIC DATA RECORD

Station: Indian

Location: S 34 T 11S R 5W

Water Year: 1977

Stream Reach Score: 67

Survey Date: 8/15/76

	1976		1977					
Date	10/25	11/20	5/2	5/12	5/19	5/31	6/13	6/25
Time	1115	1030	1100	1145	1315	1115	1145	1015
Temperature (F°)								
air	32	24	51	55	36	59	56	66
water	34	32	36	37	36	39	41	44
water (max)	ice	ice	inst	41	42	43	44	50
water (min)	ice	ice	inst	32	32	32	34	35
Precipitation (in)								
Discharge (cfs)								
instant	ice	ice	1.5	1.1	1.3	1.4	4.7	2.6
crest stage			set	2.0	2.2	2.8	5.2	4.8
Suspended								
sediment (ppm)	31	(110)	10	29	5	31	85	47
Chemical Character								
PH			8.03			8.17		8.01
ALK ($CaCO_3$) (mg/l)			142			167		178
SC (µmhos)	432	442	314	355	356	368	318	400
TDS (mg/l)	281	287	204	231	231	239	207	260
Ca "			57			60		65
Mg "			9.0			8.5		11
Na "			1.6			2.0		1.9
K "			0.83			0.75		0.60
HCO_3 "			174			204		217
SO_4 "			37			27		29
NH_4 "			--			--		.01
NO_2 & NO_3 -N "			--			.31		--
PO_4 (Ortho)-P "			--			T		.002
Biological Character								
Total Coliform (colonies/100 mls)						< 2		< 1
Fecal Coliform (colonies/100 mls)						< 2		< 1
Stock present								n

BASIC DATA RECORD

Station: Indian
Location: S 34 T 11S R 5W
Water Year: 1977

Stream Reach Score: 67
Survey Date: 8/15/76

Date	7/13	7/29	8/32	9/22	9/30
Time	1145	1230	1130	1130	1130
Temperature (F°)					
air	56	65	46	36	32
water	45	46	38	36	32
water (max)	51	54	52	48	45
water (min)	32	37	37	36	32
Precipitation (in)					
Discharge (cfs)					
instant	.86	.38	.22	.20	.18
crest stage	2.6	.86	.38	.38	.22
Suspended					
sediment (ppm)	18	< 5	9	< 5	32
Chemical Character					
PH		8.13	8.11		8.05
ALK ($CaCO_3$) (mg/l)		171	168		156
SC (µmhos)	375	378	386	405	385
TDS (mg/l)	244	246	251	263	250
Ca "		63	73		76
Mg "		12	14		15
Na "		2.1	2.3		2.6
K "		0.67	0.69		0.74
HCO_3 "		210	204		191
SO_4 "		53	62		60
NH_4 "		.05	< .01		.05
NO_2 & NO_3 -N "		.05	.07		.11
PO_4 (Ortho)-P "		T	T		.008
Biological Character					
Total Coliform (colonies/100 mls)		< 1	22		< 2
Fecal Coliform (colonies/100 mls)		< 1	23		< 2
Stock present	n	y	y	u	n

BASIC DATA RECORD

Station: Indian

Location: S 34 T 11S R 5W

Water Year: 1978

Stream Reach Score: 67

Survey Date: 8/15/76

	1977		1978					
Date	10/18	11/12	5/24	6/4	6/9	6/16	6/20	6/28
Time	1230	1630	1645	1630	1930	1245	1800	1215
Temperature (F°)								
air	52	34	32	56	59	45	61	69
water	35	33	37	44	40	39	44	43
water (max)	39	40		inst	45	43	45	46
water (min)	32	32		inst	36	36	36	37
Precipitation (in)								
Discharge (cfs)								
instant	.15	.15	1.7	.91	6.9	5.9	5.0	2.3
crest stage	.20	.15	set	1.7	6.9	7.1	5.9	5.0
Suspended sediment (ppm)	8	22	42	32	480	31	38	35
Chemical Character								
PH	7.99	8.18	7.95				8.10	
ALK ($CaCO_3$) (mg/l)	170	154	170				170	
SC (μmhos)	422	385	332	355	282	321	335	405
TDS (mg/l)	274	250	216	231	183	209	218	263
Ca "	77	67	52				53	
Mg "	15	13	9.4				10	
Na "	2.5	2.3	2.0				2.4	
K "	0.71	0.63	0.75				0.65	
HCO_3 "	207	188	204				205	
SO_4 "	65	51	15				14	
NH_4 "	.13	.02	.02				.01	
NO_2 & NO_3 -N "	.23	.16	.09				.05	
PO_4 (Ortho)-P "	.077	T	.011				.017	
Biological Character								
Total Coliform (colonies/100 mls)	12	32	133				32	
Fecal Coliform (colonies/100 mls)	< 2	< 2	< 1				< 1	
Stock present	n	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Indian
Location: S 34 T 11S R 5W
Water Year: 1978

Stream Reach Score: 67
Survey Date: 8/15/76

Date	7/6	7/18	8/17	9/15
Time	1345	1200	1245	1200
Temperature (F°)				
air	51	62	38	39
water	42	45	40	39
water (max)	47	51	51	56
water (min)	39	40	38	34
Precipitation (in)				
Discharge (cfs)				
instant	2.2	1.6	.70	.45
crest stage	4.0	3.7	1.6	.82
Suspended sediment (ppm)	21	18	33	20
Chemical Character				
PH		8.30	8.12	8.30
ALK ($CaCO_3$) (mg/l)		176	154	155
SC (μmhos)	426	458	451	462
TDS (mg/l)	277	298	293	300
Ca "		65	63	67
Mg "		12	12	13
Na "		2.1	1.3	2.6
K "		0.59	0.48	1.0
HCO_3 "		215	185	187
SO_4 "		62	60	69
NH_4 "		< .01	.01	< .01
NO_2 & NO_3 -N "		.05	.02	.03
PO_4 (Ortho)-P "		.010	.013	.004
Biological Character				
Total Coliform (colonies/100 mls)		193	80	70
Fecal Coliform (colonies/100 mls)		< 1	2	4
Stock present	n	n	y	y

BASIC DATA RECORD

Station: Lower Clark Canyon

Location: S 35 T 9S R 10W

Water Year: 1977

Stream Reach Score: 99

Survey Date: 8/13/76

	1976			1977					
Date	9/21	10/25	11/30	2/21	4/14	4/21	5/2	5/12	5/21
Time		1700	1400	1450	1230	1200	1900	1645	1800
Temperature (F°)									
air		36	30	28	38	46	52	63	46
water		43	36	34	32	45	48	55	52
water (max)	inst	--	ice		inst	48	54	59	59
water (min)	inst	--	ice		inst	32	35	35	34
Precipitation (in)									
Discharge (cfs)									
instant	2.3	2.3	2.5	ice	1.2	.52	1.2	.80	1.7
crest stage				ice	set	5.1	3.5	1.2	2.0
Suspended									
sediment (ppm)		22	52	ice	58	8	16	63	28
Chemical Character									
PH						8.24			
ALK ($CaCO_3$) (mg/l)						177			
SC (µmhos)		500	458	452	336	342	340	424	403
TDS (mg/l)		325	298	294	218	222	221	276	262
Ca "						40			
Mg "						4.6			
Na "						18			
K "						3.7			
HCO_3 "						216			
SO_4 "						10			
NH_4 "						--			
NO_2 & NO_3 -N "						$<$ .01			
PO_4 (Ortho)-P "						--			
Biological Character									
Total Coliform (colonies/100 mls)									
Fecal Coliform (colonies/100 mls)									
Stock present									

BASIC DATA RECORD

Station: Lower Clark Canyon
Location: S 35 T 9S R 10W
Water Year: 1977

Stream Reach Score: 99
Survey Date: 8/13/76

Date	5/28	6/12	6/23	7/15	7/28	8/31	9/23	9/29
Time	1915	1630	1700	1030	1230	2030	1230	1815
Temperature (F°)								
air	41	52	77	73	75	47	50	40
water	46	61	59	56	63	52	52	50
water (max)	52	79	78	70	68	66	64	57
water (min)	37	37	54	45	48	48	42	44
Precipitation (in)								
Discharge (cfs)								
instant	2.3	.50	.54	.40	.44	.26	.26	.31
crest stage	3.1	2.3	3.2	1.1	.44	.44	.26	.31
Suspended sediment (ppm)	30	9	19	32	(110)	(109)	21	16
Chemical Character								
PH	8.12		7.70		7.71	8.10		7.91
ALK ($CaCO_3$) (mg/l)	186		254		275	242		250
SC (μmhos)	367	460	510	500	503	455	495	388
TDS (mg/l)	239	299	332	325	327	296	322	252
Ca "	51		75		80	70		62
Mg "	6.0		7.4		7.6	7.8		7.4
Na "	22		26		23	29		31
K "	3.1		5.4		5.6	5.4		4.9
HCO_3 "	227		310		336	295		306
SO_4 "	8.6		9.0		8.4	12		11
NH_4 "	--		<.01		--	<.01		.10
NO_2 & NO_3-N "	<.01		<.01		<.01	.10		.07
PO_4 (Ortho)-P "	.007		--		.043	.016		.033
Biological Character								
Total Coliform (colonies/100 mls)	4		<2		17	6		88
Fecal Coliform (colonies/100 mls)	<2		8		14	2		143
Stock present			u	u	y	y	u	y

BASIC DATA RECORD

Station: Lower Clark Canyon — Stream Reach Score: 99

Location: S 35 T 9S R 10W

Water Year: 1978 — Survey Date: 8/13/76

	1977		1978						
Date	10/17	11/10	3/29	4/5	4/11	4/19	4/25	5/3	5/9
Time	1330	1800	1345	1930	1745	1930	1830	1845	1900
Temperature (F°)									
air	64	32	62	36	43	42	55	47	56
water	49	34	50	40	43	46	50	49	48
water (max)	51	32		inst	59	63	57	63	55
water (min)	35	32		inst	33	33	33	47	32
Precipitation (in)									
Discharge (cfs)									
instant	.63	.63	1.1	1.4	.22	.12	.13	.63	6.6
crest stage	.86	.78	set	7.3	1.4	.59	.22	1.2	6.6
Suspended **sediment** (ppm)	31	(208)	140	20	7	19	16	18	744
Chemical Character									
PH	8.01	7.90					8.02		
ALK ($CaCO_3$) (mg/l)	242	206					222		
SC (μmhos)	442	425	320	320	385	405	411	386	342
TDS (mg/l)	287	276	208	208	250	263	267	251	222
Ca "	71	92					65		
Mg "	7.3	8.4					7.7		
Na "	28	28					28		
K "	3.1	2.2					2.8		
HCO_3 "	296	251					266		
SO_4 "	8	7					8		
NH_4 "	.14	< .01					.01		
NO_2 & NO_3 -N "	.01	.05					.02		
PO_4 (Ortho)-P "	.009	.001					.007		
Biological Character									
Total Coliform (colonies/100 mls)	71	66					546		
Fecal Coliform (colonies/100 mls)	51	58					--		
Stock present	y	y	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Lower Clark Canyon
Location: S 35 T 9S R 10W
Water Year: 1978

Stream Reach Score: 99
Survey Date: 8/13/78

Date	5/26	6/2	6/8	6/13	6/19	6/27	7/18	8/16	9/13
Time	1500	1800	1830	2100	2015	1715	1845	2100	1915
Temperature (F°)									
air	52	52	74	64	52	63	72	41	43
water	45	53	57	52	50	54	57	48	49
water (max)	set	56	62	60	59	61	63	67	64
water (min)	set	38	43	42	41	41	45	45	41
Precipitation (in)									
Discharge (cfs)									
instant	9.4	2.4	4.1	4.5	2.3	1.4	1.2	1.2	.98
crest stage	$\geq$ 9.4	9.4	4.1	4.5	4.5	3.3	5.9	1.2	1.2
Suspended sediment (ppm)	119	28	34	28	25	24	36	60	92
Chemical Character									
PH	7.85				8.03		8.19	8.23	8.27
ALK ($CaCO_3$) (mg/l)	148				216		245	221	234
SC (μmhos)	284	352	361	369	433	512	495	500	515
TDS (mg/l)	185	229	235	240	281	333	322	325	335
Ca "	37				88		58	61	60
Mg "	4.1				7.4		7.3	6.5	6.7
Na "	17				26		26	23	26
K "	2.8				1.4		4.0	2.8	4.2
HCO_3 "	178				259		298	269	286
SO_4 "	4				8		10	10	11
NH_4 "	.01				<.01		.01	<.01	<.01
NO_2 & NO_3 -N "	.08				<.01		.02	.02	.03
PO_4 (Ortho)-P "	.041				.055		.028	.009	.007
Biological Character									
Total Coliform (colonies/100 mls)	1320				6370		18100	1000	5020
Fecal Coliform (colonies/100 mls)	<1				409		100	83	87
Stock present	y	y	y	y	y	y	u	u	u

BASIC DATA RECORD

Station: Upper Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1977

Stream Reach Score: 109
Survey Date: 8/13/76

	1976			1977					
Date	9/21	10/25	11/30	4/14	4/21	5/2	5/12	5/21	5/28
Time		1530	1330	1145	1045	1800	1545	1715	1800
Temperature (F°)									
air		36	30	32	49	49	70	56	44
water		39	36	34	35	44	50	47	43
water (max)	inst	47	--	39	41	46	50	50	47
water (min)	inst	32	32	32	32	34	32	31	36
Precipitation (in)									
Discharge (cfs)									
instant	1.6	1.3	.93	1.9	2.8	3.5	1.7	3.2	3.9
crest stage		set	1.4	set	(11)	(14)	5.1	5.1	8.5
Suspended sediment (ppm)		7	34	114	17	27	178	122	179
Chemical Character									
PH					7.95				8.12
ALK ($CaCO_3$) (mg/l)					111				129
SC (µmhos)		368	375	272	205	242	300	273	270
TDS (mg/l)		239	244	127	133	157	195	177	176
Ca "					24				37
Mg "					3.3				4.1
Na "					10				17
K "					3.5				2.4
HCO_3 "					136				158
SO_4 "					7				6
NH_4 "					--				--
NO_2 & NO_3-N "					.06				.03
PO_4 (Ortho)-P "					--				.026
Biological Character									
Total Coliform (colonies/100 mls)									2
Fecal Coliform (colonies/100 mls)									< 2
Stock present									

BASIC DATA RECORD

Station: Upper Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1977

Stream Reach Score: 109
Survey Date: 8/13/76

Date	6/12	6/23	7/15	7/28	8/31	9/23	9/29
Time	1530	1600	0915	1100	1915	1000	1645
Temperature (F°)							
air	62	72	59	72	48	39	41
water	55	54	46	51	46	38	45
water (max)	57	63	54	57	55	52	47
water (min)	36	43	41	45	42	34	37
Precipitation (in)							
Discharge (cfs)							
instant	3.9	2.4	1.4	1.6	.85	.69	.85
crest stage	7.1	8.7	2.6	3.2	1.6	.85	.85
Suspended sediment (ppm)	28	22	26	60	20	18	42
Chemical Character							
PH		8.11		7.90	8.11		8.20
ALK ($CaCO_3$) (mg/l)		202		212	209		201
SC (μmhos)	372	395	368	355	371	400	368
TDS (mg/l)	424	257	239	231	241	260	239
Ca "		65		61	69		74
Mg "		5.8		5.8	6.2		6.5
Na "		15		15	16		18
K "		2.0		1.9	2.0		2.4
HCO_3 "		247		258	255		245
SO_4 "		4		6	7		9
NH_4 "		< .01		--	< .01		.15
NO_2 & NO_3 -N "		.06		.15	.28		.38
PO_4 (Ortho)-P "		.040		.052	.047		.046
Biological Character							
Total Coliform (colonies/100 mls)		< 2		85	17		13
Fecal Coliform (colonies/100 mls)		8		<2	8		14
Stock present		u	y	y	u	y	y

BASIC DATA RECORD

Station: Upper Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1978

Stream Reach Score: 109

Survey Date: 8/13/76

	1977		1978						
Date	10/17	11/10	3/29	4/5	4/11	4/19	4/25	5/3	5/9
Time	1100	1645	1230	1815	1630	1895	1700	1745	1830
Temperature (F°)									
air	46	34	60	39	41	43	57	47	55
water	41	38	39	39	39	41	44	44	43
water (max)	46	46	inst	46	45	46	46	47	50
water (min)	36	34	inst	33	34	32	32	32	32
Precipitation (in)									
Discharge (cfs)									
instant	1.7	.76	2.4	1.1	1.3	1.3	1.2	2.2	5.8
crest stage	1.7	1.7	set	5.3	1.9	1.5	1.3	3.3	5.8
Suspended sediment (ppm)	5	25	13	7	5	11	12	16	525
Chemical Character									
PH	7.91	7.83					7.88		
ALK ($CaCO_3$) (mg/l)	213	187					171		
SC (µmhos)	392	380	260	302	298	303	295	258	226
TDS (mg/l)	255	247	169	196	194	197	192	168	147
Ca "	61	78					46		
Mg "	6.5	7.4					4.6		
Na "	19	19					16		
K "	1.8	1.6					1.3		
HCO_3 "	260	228					206		
SO_4 "	5	5					4		
NH_4 "	.13	<.01					.01		
NO_2 & NO_3 -N "	.40	.09					.02		
PO_4 (Ortho)-P "	.034	.018					.051		
Biological Character									
Total Coliform (colonies/100 mls)	16	30					462		
Fecal Coliform (colonies/100 mls)	7	17					--		
Stock present	u	u	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Upper Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1978

Stream Reach Score: 109
Survey Date: 8/13/76

Date	5/26	6/2	6/8	6/13	6/19	6/27	7/18	8/16	9/13
Time	1330	1600	1730	1930	2100	1815	1645	1900	1730
Temperature (F°)									
air	52	52	73	63	42	63	72	43	49
water	41	50	55	51	46	52	50	44	45
water (max)	53	53	63	64	57	64	66	--	--
water (min)	34	36	41	40	39	39	43	42	40
Precipitation (in)									
Discharge (cfs)									
instant	11	1.8	2.4	4.0	2.0	1.2	1.8	1.5	1.3
crest stage	20	11	4.3	4.3	4.8	2.3	2.4	2.8	2.2
Suspended sediment (ppm)	35	19	18	24	23	15	13	32	10
Chemical Character									
PH	7.76				8.11		8.00	8.17	8.19
ALK ($CaCO_3$) (mg/l)	128				195		214	186	183
SC (µmhos)	226	260	286	304	346	414	410	422	427
TDS (mg/l)	147	169	186	198	225	269	266	274	278
Ca "	32				56		58	57	57
Mg "	3.5				6.2		6.4	5.4	5.6
Na "	13				15		15	15	15
K "	1.8				1.9		2.2	1.6	2.5
HCO_3 "	153				235		260	227	224
SO_4 "	3				3		6	2	6
NH_4 "	.02				< .01		.02	.25	< .01
NO_2 & NO_3-N "	.10				.03		.08	.09	.05
PO_4 (Ortho)-P "	.046				.026		.046	.053	.039
Biological Character									
Total Coliform (colonies/100 mls)	515				3400		2730	>10000	270
Fecal Coliform (colonies/100 mls)	1				9		387	33	9
Stock present	n	n	n	n	n	u	y	y	u

BASIC DATA RECORD

Station: E. Fork Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1977

Stream Reach Score: 97
Survey Date: 8/13/76

	1976		1977					
Date	10/25	11/30	4/14	4/21	5/2	5/12	5/21	5/28
Time	1615	1330	1215	1115	1815	1610	1745	1845
Temperature (F°)								
air	34	30	38	50	48	68	55	45
water	36	32	32	39	44	61	50	46
water (max)	66	ice	ice	ice	inst	64	64	59
water (min)	32	ice	ice	ice	inst	32	32	32
Precipitation (in)				inst	0.23	0.45	1.66	0.88
Discharge (cfs)								
instant	.65	ice	< 1.5	< 1.5	< 1.0	< .5	< 1.0	<.5
crest stage								
Suspended								
sediment (ppm)	31	ice	543	153	465	48	1140	164
Chemical Character								
PH				8.00				8.01
ALK ($CaCO_3$) (mg/l)				118				147
SC (µmhos)	441	479	227	238	235	297	304	312
TDS (mg/l)	278	311	148	155	153	193	198	203
Ca "				20				32
Mg "				3.5				4.9
Na "				22				28
K "				4.6				5.6
HCO_3 "				144				180
SO_4 "				22				18
NH_4 "				--				--
NO_2 & NO_3 -N "				.03				<.01
PO_4 (Ortho) -P"				--				.059
Biological Character								
Total Coliform								
(colonies/100 mls)								10
Fecal Coliform								
(colonies/100 mls)								4
Stock present								

BASIC DATA RECORD

Station: E. Fork Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1977

Stream Reach Score: 97
Survey Date: 8/13/76

Date	6/12	6/23	7/15	7/28	8/31	9/23	9/29
Time	1600	1630	1000	1130	1945	1100	1700
Temperature (F°)							
air	57	81	66	72	48	48	37
water	63	72	56	64	50	39	38
water (max)	72	73	79	--	--	73	50
water (min)	32	52	39	--	36	32	32
Precipitation (in)	1.39	0.96	0.74	1.19	1.17	> 1.29	0.57
Discharge (cfs)							
instant	< .5	< .5	< .10	< .10	< .10	< .5	< .15
crest stage							
Suspended sediment (ppm)	269	23	32	18	34	231	9390
Chemical Character							
PH		8.21		8.37	8.32		8.11
ALK ($CaCO_3$) (mg/l)		281		215	207		100
SC (µmhos)	358	600	540	402	412	412	204
TDS (mg/l)	233	390	351	261	268	268	133
Ca "		64		47	44		20
Mg "		8.3		6.4	6.3		2.7
Na "		56		42	48		28
K "		7.6		7.2	7.1		5.0
HCO_3 "		343		257	252		122
SO_4 "		23		22	19		27
NH_4 "		< .01		--	< .01		.11
NO_2 & NO_3-N "		.04		.08	.04		--
PO_4 (Ortho)-P "		.010		.060	.059		--
Biological Character							
Total Coliform (colonies/100 mls)		2		1000	220		TNTC
Fecal Coliform (colonies/100 mls)		8		940	140		TNTC
Stock present			u	u	u	y	u

BASIC DATA RECORD

Station: E. Fork Clark Canyon

Location: S 6 T 10S R 9W

Water Year: 1978

Stream Reach Score: 97

Survey Date: 8/13/76

	1977		1978						
Date	10/17	11/10	3/29	4/5	4/11	4/19	4/25	5/3	5/9
Time	1130	1700	1300	1845	1700	1900	1730	1730	1815
Temperature (F°)									
air	54	34	61	39	44	43	57	48	55
water	37	32	34	34	36	38	41	45	43
water (max)	47	52	ice	ice	inst	45	50	54	52
water (min)	32	32	ice	ice	inst	32	32	33	37
Precipitation (in)	0.24	0.32		inst	0.28	0.57	0.07	0.62	1.16
Discharge (cfs)									
instant	<.10*	ice	.53	.18	.16	.18	.34	.34	2.6
crest stage									
Suspended sediment (ppm)	29	15	714	63	140	242	315	123	11500
Chemical Character									
PH	8.01	7.79					7.71		
ALK ($CaCO_3$) (mg/l)	205	175					156		
SC (µmhos)	420	380	215	305	262	289	280	255	228
TDS (mg/l)	273	247	140	198	170	188	182	166	148
Ca "	53	53					24		
Mg "	7.5	8.3					4.1		
Na "	58	44					34		
K "	8.0	6.4					4.3		
HCO_3 "	250	213					187		
SO_4 "	17	15					8		
NH_4 "	.07	<.01					.01		
NO_2 & NO_3 -N "	.01	.06					.03		
PO_4 (Ortho)-P "	.074	.030					.048		
Biological Character									
Total Coliform (colonies/100 mls)	16	80					2750		
Fecal Coliform (colonies/100 mls)	5	65					--		
Stock present	y	y	n	n	n	n	n	n	n

*Stationed moved

BASIC DATA RECORD

Station: E. Fork Clark Canyon
Location: S 6 T 10S R 9W
Water Year: 1978

Stream Reach Score: 97
Survey Date: 8/13/76

Date	5/26	6/2	6/8	6/13	6/19	6/27	7/18	8/16	9/13
Time	1400	1700	1745	2015	2130	1830	1730	2000	1830
Temperature (F°)									
air	48	63	77	66	43	62	71	41	47
water	43	56	63	55	47	60	66	47	46
water (max)	set	58	65	64	63	68	dry	dry	dry
water (min)	set	34	41	39	39	32	dry	dry	dry
Precipitation (in)	4.05	0.40	0.00	0.46	0.14	0.89	1.66	1.29	> 2.02
Discharge (cfs)									
instant	2.2	1.6	.30	.30	.15	.10	.17	.16	.43
crest stage									
Suspended sediment (ppm)	56	30	20	23	15	29	48	113	1496
Chemical Character									
PH	7.70				8.05		8.15	8.25	8.15
ALK ($CaCO_3$) (mg/l)	85				128		217	147	146
SC (μmhos)	178	199	215	231	158	313	340	375	343
TDS (mg/l)	116	129	140	150	168	203	221	244	223
Ca "	19				31		30	32	29
Mg "	3.2				5.5		5.3	4.3	11
Na "	15				24		30	31	38
K "	2.9				4.5		8.5	4.8	4.3
HCO_3 "	102				154		265	179	173
SO_4 "	5				9		16	32	15
NH_4 "	.02				.09		.01	.13	< .01
NO_2 & NO_3 -N "	.04				< .01		.02	.02	.03
PO_4 (Ortho)-P "	.069				.074		.088	.108	.085
Biological Character									
Total Coliform (colonies/100 mls)	1100				2400		22700	2670	2870
Fecal Coliform (colonies/100 mls)	3				28		267	303	33
Stock present	n	n	y	u	u	u	u	u	u

BASIC DATA RECORD

Station: Little Sage
Location: S 7 T 12S R 7W
Water Year: 1977

Stream Reach Score: 67
Survey Date: 8/15/76

	1976			1977					
Date	9/21	10/27	11/30	2/26	4/14	4/21	5/1	5/11	5/21
Time		1000	0900	1200	1500	1330	1030	1015	1030
Temperature (F°)									
air		32	19	28	32	57	61	45	54
water		34	32	32	37	42	41	38	41
water (max)					inst	50	52	55	56
water (min)					inst	32	36	34	35
Precipitation (in)						inst	0.09	1.38	1.35
Discharge (cfs)									
instant	1.5	1.2	1.1	.77	1.3	1.1	.69	.85	1.4
crest stage					set	3.5	2.1	1.7	1.9
Suspended									
sediment (ppm)		11	35	14	14	5	< 5	81	58
Chemical Character									
PH						7.89			
ALK ($CaCO_3$) (mg/l)						183			
SC (μmhos)		375	383	392	365	358	405	418	425
TDS (mg/l)		244	249	255	237	233	263	272	276
Ca "						44			
Mg "						7.8			
Na "						9.8			
K "						7.9			
HCO_3 "						233			
SO_4 "						6			
NH_4 "						--			
NO_2 & NO_3 -N "						.11			
PO_4 (Ortho)-P "						--			
Biological Character									
Total Coliform (colonies/100 mls)									
Fecal Coliform (colonies/100 mls)									
Stock present									

BASIC DATA RECORD

Station: Little Sage
Location: S 7 T 12S R 7W
Water Year: 1977

Stream Reach Score: 67
Survey Date: 8/15/76

Date	5/28	6/13	6/23	7/12	7/26	8/29	9/17	9/27
Time	1030	1630	0930	0800	1015	1030	1145	1600
Temperature (F°)								
air	43	57	68	58	51	55	42	63
water	39	59	54	48	52	48	46	50
water (max)	54	66	66	72	69	66	54	61
water (min)	36	36	43	44	46	41	39	36
Precipitation (in)	0.78	1.70	n.s.	$>$0.15	1.54	0.95	0.82	1.00
Discharge (cfs)								
instant	1.4	1.2	.99	1.1	1.2	1.2	1.2	1.1
crest stage	1.9	1.8	1.2	1.8	1.7	1.5	1.7	1.3
Suspended sediment (ppm)	30	15	17	55	99	20	20	10
Chemical Character								
PH	7.82		7.98		7.95	8.19		8.30
ALK ($CaCO_3$) (mg/l)	210		199		198	182		171
SC (µmhos)	428	394	415	322	353	333	359	327
TDS (mg/l)	278	256	270	216	229	216	233	213
Ca "	61		58		60	57		58
Mg "	9.4		9.2		9.2	9.1		9.1
Na "	13		12		11	12		12
K "	6.9		5.9		6.6	6.2		6.8
HCO_3 "	256		243		241	222		208
SO_4 "	8		5		5	6		6
NH_4 "	--		$<$.01		--	.02		.09
NO_2 & NO_3-N "	.01		$<$.01		.01	.09		.08
PO_4 (Ortho)-P "	T		.014		.023	.003		.014
Biological Character								
Total Coliform (colonies/100 mls)	8		370		320	40		6
Fecal Coliform (colonies/100 mls)	12		390		588	50		9
Stock present			y	y	y	u	u	u

BASIC DATA RECORD

Station: Little Sage
Location: S 7 T 12S R 7W
Water Year: 1978

Stream Reach Score: 67
Survey Date: 8/15/76

	1977 10/15	11/13	1978 4/4	4/12	4/19	4/26	5/4	5/10	5/26
Time	1645	1215	1230	1315	1215	1345	1245	1245	2000
Temperature (F°)									
air	64	48	39	49	55	54	34	51	49
water	46	35	38	39	42	46	47	46	52
water (max)	50	48	inst	38	50	52	54	55	59
water (min)	34	32	inst	34	34	36	36	36	37
Precipitation (in)	.61	0.41	inst	0.66	0.27	n.s.	1.15	0.20	0.76
Discharge (cfs)									
instant	1.2	1.2	1.1	1.3	.85	1.2	.77	.85	1.1
crest stage	1.5	1.6	set	1.8	1.5	1.3	1.4	1.3	1.6
Suspended sediment (ppm)	22	5	24	23	15	21	35	29	25
Chemical Character									
PH	7.85	8.05				7.70			8.28
ALK ($CaCO_3$) (mg/l)	168	163				197			169
SC (μmhos)	335	325	342	342	363	370	371	368	328
TDS (mg/l)	218	211	222	222	236	240	241	239	213
Ca "	58	70				60			40
Mg "	9.7	11				9.7			7.3
Na "	14	14				13			10
K "	7.3	7.2				8.3			5.6
HCO_3 "	205	198				236			203
SO_4 "	5.	5				3			3
NH_4 "	.03	.09				.01			.01
NO_2 & NO_3 -N "	.14	.09				.06			.01
PO_4 (Ortho)-P "	.013	.006				.022			.086
Biological Character									
Total Coliform (colonies/100 mls)	43	17				2100			3800
Fecal Coliform (colonies/100 mls)	18	8				--			2
Stock present	y	y	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Little Sage
Location: S 7 T 12S R 7W
Water Year: 1978

Stream Reach Score: 67
Survey Date: 8/15/76

Date	5/31	6/8	6/14	6/19	6/27	7/19	8/14	9/11
Time	1800	1200	2000	1745	1600	1915	1745	1730
Temperature (F°)								
air	46	66	57	61	73	60	54	43
water	50	53	56	60	63	60	53	49
water (max)	60	64	66	63	64	66	65	57
water (min)	39	42	43	44	43	47	47	43
Precipitation (in)	0.05	0.00	0.40	0.18	0.32	0.17	0.41	1.63
Discharge (cfs)								
instant	1.2	.77	.69	.92	.60	.50	.92	1.4
crest stage	1.3	1.2	1.2	1.3	.92	1.6	1.3	1.5
Suspended sediment (ppm)	30	29	32	52	63	51	50	30
Chemical Character								
PH				8.50		8.25	8.60	8.38
ALK ($CaCO_3$) (mg/l)				152		154	173	148
SC (µmhos)	323	345	305	292	342	319	348	368
TDS (mg/l)	210	224	198	190	222	207	226	239
Ca "				40		38	45	47
Mg "				7.8		7.8	7.0	8.0
Na "				13		12	11	11
K "				5.4		8.5	5.7	7.7
HCO_3 "				183		188	202	170
SO_4 "				5		2	6	6
NH_4 "				< .01		.01	< .01	< .01
NO_2 & NO_3 -N "				< .01		< .01	.01	< .01
PO_4 (Ortho)-P "				.024		.034	.027	.032
Biological Character								
Total Coliform (colonies/100 mls)				17800		70300	24300	38000
Fecal Coliform (colonies/100 mls)				17		29	85	2000
Stock present	y	y	u	u	u	u	u	y

BASIC DATA RECORD

Station: Lower Basin

Location: S 30 T 12S R 7W

Water Year: 1977

Stream Reach Score: 49

Survey Date: 8/17/76

	1976			1977					
Date	9/21	10/27	11/30	2/26	4/14	4/21	5/1	5/11	5/21
Time		1315	1130	1230	1800	1600	1230	1215	1230
Temperature (F°)									
air		43	27	25	30	49	55	55	61
water		34	32	32	41	51	50	46	55
water (max)	inst	66			inst	54	64	66	66
water (min)	inst	34			inst	34	36	34	35
Precipitation (in)									
Discharge (cfs)									
instant	3.0	2.1	2.3	ice	2.6	.39	.52	.61	.66
crest stage		set	$\geqslant$ 2.3	ice	set	(15)	4.1	3.3	3.2
Suspended sediment (ppm)		49	67	104	146	24	63	59	35
Chemical Character									
PH						8.19			
ALK ($CaCO_3$) (mg/l)						217			
SC (µmhos)		358	425	435	340	448	456	478	436
TDS (mg/l)		233	276	283	221	291	296	311	283
Ca "						48			
Mg "						15			
Na "						9.5			
K "						6.3			
HCO_3 "						265			
SO_4 "						18			
NH_4 "						--			
NO_2 & NO_3 -N "						.23			
PO_4 (Ortho)-P "						--			
Biological Character									
Total Coliform (colonies/100 mls)									
Fecal Coliform (colonies/100 mls)									
Stock present									

BASIC DATA RECORD

Station: Lower Basin
Location: S 30 T 12S R 7W
Water Year: 1977

Stream Reach Score: 49
Survey Date: 8/17/76

Date	5/28	6/13	6/23	7/12	7/26	8/29	9/17	9/27
Time	1245	1900	1400	1130	1300	1245	1715	1815
Temperature (F°)								
air	46	57	79	73	65	63	48	58
water	48	65	72	61	58	54	50	52
water (max)	63	80	75	79	77	74	65	54
water (min)	37	38	45	45	48	43	41	37
Precipitation (in)								
Discharge (cfs)								
instant	2.4	.95	.77	.49	.75	.68	.86	.81
crest stage	2.4	(9.4)	.95	.81	1.2	.86	.86	1.6
Suspended sediment (ppm)	79	10	22	12	18	< 5	< 5	< 5
Chemical Character								
PH	8.18		8.48		8.58	8.62		8.35
ALK ($CaCO_3$) (mg/l)	216		171		148	166		139
SC (µmhos)	447	368	378	368	372	315	278	272
TDS (mg/l)	291	239	246	239	242	205	181	177
Ca "	58		44		46	49		47
Mg "	14		14		11	14		10
Na "	13		9.1		9.2	9.1		9.2
K "	4.0		4.1		3.8	5.2		5.0
HCO_3 "	264		209		166	182		165
SO_4 "	19		10		8	8		9
NH_4 "	--		< .01		--	.04		.09
NO_2 & NO_3 -N "	.04		< .01		< .01	.03		.07
PO_4 (Ortho)-P "	< .001		(.120)		< .001	< .001		--
Biological Character								
Total Coliform (colonies/100 mls)	< 1		< 1		7	38		510
Fecal Coliform (colonies/100 mls)	< 1		7		120	24		490
Stock present			u	u	u	y	y	y

BASIC DATA RECORD

Station: Lower Basin

Location: S 30 T 12S R 7W

Water Year: 1978

Stream Reach Score: 49

Survey Date: 8/16/76

	1977		1978						
Date	10/15	11/13	4/4	4/12	4/19	4/26	5/4	5/10	5/26
Time	1900	1130	1145	1230	1145	1315	1215	1200	1915
Temperature (F°)									
air	51	48	39	45	54	47	32	50	52
water	47	34	38	43	45	47	40	46	51
water (max)	53	49	inst	55	54	56	55	62	63
water (min)	34	34	inst	32	32	32	32	32	34
Precipitation (in)									
Discharge (cfs)									
instant	.90	1.7	.39	.43	.26	2.7	.68	1.9	2.7
crest stage	2.6	ice	set	1.4	.92	2.7	6.7	2.1	(14)
Suspended sediment (ppm)	6	22	20	15	21	99	33	71	28
Chemical Character									
PH	7.89	8.00				7.95			8.28
ALK ($CaCO_3$) (mg/l)	151	149				211			167
SC (μmhos)	310	300	318	412	420	420	356	393	323
TDS (mg/l)	202	195	207	268	273	273	231	255	210
Ca "	50	59				59			41
Mg "	11	11				14			8.8
Na "	9.5	8.7				10			6.8
K "	5.3	5.3				5.5			2.6
HCO_3 "	184	182				253			201
SO_4 "	6	6				10			7
NH_4 "	.06	.07				.09			< .01
NO_2 & NO_3 -N "	.13	.07				.31			< .01
PO_4 (Ortho)-P "	.008	.001				.009			.027
Biological Character									
Total Coliform (colonies/100 mls)	210	30				9600			2900
Fecal Coliform (colonies/100 mls)	230	8				--			< 2
Stock present	y	y	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Lower Basin
Location: S 30 T 12S R 7W
Water Year: 1978

Stream Reach Score: 49
Survey Date: 8/16/76

Date	5/31	6/8	6/14	6/19	6/27	7/19	8/14	9/11
Time	1700	1115	1930	1715	1530	1830	1630	1630
Temperature (F°)								
air	48	66	66	61	74	74	54	43
water	47	55	60	59	67	68	52	46
water (max)	63	70	72	68	71	75	74	65
water (min)	39	39	43	44	43	49	48	42
Precipitation (in)								
Discharge (cfs)								
instant	2.9	1.3	1.8	2.5	1.8	.95	1.0	3.1
crest stage	3.0	3.0	5.3	2.5	3.1	2.6	2.0	3.1
Suspended sediment (ppm)	40	21	20	23	18	18	21	22
Chemical Character								
PH				8.47		8.72	8.87	8.55
ALK ($CaCO_3$) (mg/l)				165		140	154	150
SC (μmhos)	322	326	313	318	351	382	299	377
TDS (mg/l)	209	212	203	207	228	248	194	245
Ca "				44		(28)	32	44
Mg "				11		14	14	15
Na "				8.2		8.2	8.0	8.2
K "				2.6		3.4	2.5	3.9
HCO_3 "				198		158	166	177
SO_4 "				15		24	22	26
NH_4 "				$<.01$		.04	$<.01$	$<.01$
NO_2 & NO_3 -N "				$<.01$		.01	$<.01$	$<.01$
PO_4 (Ortho)-P "				.026		.016	.007	.012
Biological Character								
Total Coliform (colonies/100 mls)				17200		22700	2670	11600
Fecal Coliform (colonies/100 mls)				20		27	15	307
Stock present	n	n	n	n	n	n	u	u

BASIC DATA RECORD

Station: Upper Basin
Location: S 36 T 12S R 7W
Water Year: 1977

Stream Reach Score: 74
Survey Date: 8/16/76

	1976			1978					
Date	9/22	10/27	11/30	4/14	4/21	5/1	5/11	5/21	5/28
Time		1115	0930	1600	1445	1130	1115	1145	1130
Temperature (F°)									
air		34	23	32	55	70	46	50	41
water		34	32	39	43	46	41	45	41
water (max)	inst	55		inst	44	52	54	55	52
water (min)	inst	34		inst	34	36	32	36	36
Precipitation (in)					inst	0.04	1.29	1.36	0.97
Discharge (cfs)									
instant	1.4	1.3	1.4	1.4	1.4	1.0	1.3	1.4	1.6
crest stage				set	(11)	5.5	2.4	2.4	2.0
Suspended sediment (ppm)		11	10	9	10	<5	24	<5	7
Chemical Character									
PH					7.90				8.03
ALK ($CaCO_3$) (mg/l)					134				146
SC (µmhos)		312	320	242	262	269	284	287	292
TDS (mg/l)		203	208	157	170	175	185	187	190
Ca "					38				49
Mg "					4.9				5.6
Na "					4.2				5.5
K "					3.3				2.9
HCO_3 "					164				178
SO_4 "					6				7
NH_4 "					--				--
NO_2 & NO_3-N "					(.19)				$<.01$
PO_4 (Ortho)-P "					--				.038
Biological Character									
Total Coliform (colonies/100 mls)									<1
Fecal Coliform (colonies/100 mls)									<1
Stock present									

BASIC DATA RECORD

Station: Upper Basin
Location: S 36 T 12S R 7W
Water Year: 1977

Stream Reach Score: 74
Survey Date: 8/16/76

Date	6/13	6/23	7/12	7/26	8/29	9/17	9/27
Time	1730	1030	0930	1130	1130	1400	1700
Temperature (F°)							
air	61	68	62	55	57	44	60
water	57	57	50	54	50	45	51
water (max)	66	63	64	68	66	59	53
water (min)	37	45	45	46	43	41	36
Precipitation (in)	1.97	n.s.	> 0.73	1.76	1.12	0.85	0.86
Discharge (cfs)							
instant	1.4	1.0	.88	1.2	1.2	1.2	1.0
crest stage	3.6	1.4	1.3	1.2	1.4	1.2	1.7
Suspended							
sediment (ppm)	11	18	15	23	11	12	< 5
Chemical Character							
PH		8.00		7.97	8.21		8.01
ALK ($CaCO_3$) (mg/l)		169		172	176		166
SC (μmhos)	312	345	297	303	303	313	303
TDS (mg/l)	203	224	193	197	197	203	197
Ca "		52		60	62		63
Mg "		6.3		6.6	7.8		7.8
Na "		5.5		5.4	6.5		7.0
K "		2.3		3.4	3.6		3.9
HCO_3 "		207		209	215		202
SO_4 "		3		4	4		3
NH_4 "		< .01		--	.04		.08
NO_2 & NO_3 -N "		.01		.11	.09		.08
PO_4 (Ortho) -P "		.082		.119	.098		.090
Biological Character							
Total Coliform (colonies/100 mls)		<1		512	195		29
Fecal Coliform (colonies/100 mls)		4		83	245		22
Stock present		u	u	u	u	y	u

BASIC DATA RECORD

Station: Upper Basin
Location: S 36 T 12S R 7W
Water Year: 1978

Stream Reach Score: 74
Survey Date: 8/16/76

	1977		1978						
Date	10/15	11/13	4/4	4/12	4/19	4/26	5/4	5/10	5/26
Time	1800	1030	0945	1030	1100	1130	1045	1115	1800
Temperature (F°)									
air	57	42	37	37	46	40	31	52	48
water	46	34	36	36	39	41	36	43	46
water (max)	52	47	inst	47	45	46	48	50	55
water (min)	41	33	inst	32	32	36	35	33	36
Precipitation (in)	0.80	0.35	inst	1.07	0.53	0.56	0.35	0.20	1.48
Discharge (cfs)									
instant	1.3	1.2	1.4	1.3	1.3	2.8	1.8	2.6	2.6
crest stage	1.7	1.3	set	3.2	1.9	3.0	4.8	2.6	7.0
Suspended sediment (ppm)	<5	18	20	15	15	27	21	21	16
Chemical Character									
PH	7.69	7.90				7.75			8.01
ALK ($CaCO_3$) (mg/l)	148	141				141			141
SC (µmhos)	295	267	242	263	260	258	247	265	268
TDS (mg/l)	192	174	157	171	169	168	161	172	174
Ca "	54	55				46			35
Mg "	6.8	6.4				5.6			4.5
Na "	6.0	6.4				4.0			3.6
K "	3.1	3.4				2.6			2.0
HCO_3 "	181	172				170			170
SO_4 "	6	3				3			2
NH_4 "	.08	.08				.01			.01
NO_2 & NO_3 -N "	.09	.10				.02			.01
PO_4 (Ortho)-P "	.004	.025				.057			.086
Biological Character									
Total Coliform (colonies/100 mls)	93	37				2120			1020
Fecal Coliform (colonies/100 mls)	68	25				--			1
Stock present	y	u	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Upper Basin
Location: S 36 T 12S R 7W
Water Year: 1978

Stream Reach Score: 74
Survey Date: 8/16/76

Date	5/31	6/8	6/14	6/19	6/27	7/19	8/14	9/11
Time	1515	1015	1830	1615	1430	1645	1345	1445
Temperature (F°)								
air	39	59	67	59	69	62	50	43
water	45	50	55	55	57	59	49	44
water (max)	55	61	63	57	62	65	64	61
water (min)	37	39	42	43	42	46	46	37
Precipitation (in)	0.13	0.05	0.53	0.17	0.76	0.23	0.45	2.10
Discharge (cfs)								
instant	2.2	1.7	1.3	1.4	1.0	.80	.78	1.4
crest stage	2.6	2.2	2.4	1.4	1.7	1.0	.90	1.6
Suspended sediment (ppm)	28	21	32	34	32	23	57	63
Chemical Character								
PH				8.07		8.03	8.25	8.00
ALK ($CaCO_3$) (mg/l)				165		173	185	152
SC (µmhos)	272	288	291	298	339	354	363	344
TDS (mg/l)	177	187	189	194	220	230	236	224
Ca "				47		50	55	45
Mg "				7.0		7.6	6.6	6.5
Na "				5.1		5.9	5.5	6.0
K "				2.2		3.1	3.0	4.3
HCO_3 "				198		212	226	185
SO_4 "				3		5	3	5
NH_4 "				.02		.02	$<$ .01	.03
NO_2 & NO_3-N "				.01		.05	.05	.01
PO_4 (Ortho)-P "				.092		.112	.139	.122
Biological Character								
Total Coliform (colonies/100 mls)				8270		24200	2370	34300
Fecal Coliform (colonies/100 mls)				2		161	1260	1590
Stock present	n	n	n	n	n	u	y	y

BASIC DATA RECORD

Station: Little Basin
Location: S 1 T 13S R 7W
Water Year: 1977

Stream Reach Score: 67
Survey Date: 8/16/76

	1976 10/27	11/30	1977 4/14	4/21	5/1	5/11	5/21	5/28	6/13
Date	10/27	11/30	4/14	4/21	5/1	5/11	5/21	5/28	6/13
Time	1215	1000	1645	1515	1200	1145	1200	1200	1800
Temperature (F°)									
air	30	23	30	48	68	46	54	46	57
water	36	32	45	49	50	45	50	43	63
water (max)	ice		inst	54	59	61	61	57	73
water (min)	ice		inst	32	37	35	37	35	37
Precipitation (in)									
Discharge (cfs)									
instant	2.3	ice	1.5	1.2	1.4	1.8	1.9	3.1	2.5
crest stage	set	ice	set	5.0	3.0	4.8	3.4	3.7	3.1
Suspended sediment (ppm)	6	ice	26	13	5	31	22	19	< 5
Chemical Character									
PH				8.20				8.21	
ALK ($CaCO_3$) (mg/l)				192				230	
SC (μmhos)	425	428	380	407	407	439	454	504	460
TDS (mg/l)	276	278	247	265	265	285	295	328	299
Ca "				47				63	
Mg "				16				20	
Na "				5.3				15	
K "				1.8				1.8	
HCO_3 "				234				281	
SO_4 "				33				26	
NH_4 "				--				--	
NO_2 & NO_3-N "				.06				.07	
PO_4 (Ortho)-P "				--				--	
Biological Character									
Total Coliform (colonies/100 mls)									
Fecal Coliform (colonies/100 mls)									
Stock present									

BASIC DATA RECORD

Station: Little Basin

Location: S 1 T 13S R 7W

Water Year: 1977

Stream Reach Score: 67

Survey Date: 8/16/76

Date	6/23	7/12	7/26	8/29	9/17	9/27
Time	1300	1030	1200	1200	1600	1730
Temperature (F°)						
air	72	67	57	57	44	60
water	64	57	59	53	48	52
water (max)	72	75	77	73	64	54
water (min)	48	48	50	43	41	38
Precipitation (in)						
Discharge (cfs)						
instant	1.3	.71	.78	.85	1.9	1.6
crest stage	2.4	1.4	.78	1.2	2.4	1.9
Suspended sediment (ppm)	5	28	< 5	< 5	< 5	< 5
Chemical Character						
PH	8.39		8.07	8.51		8.39
ALK ($CaCO_3$) (mg/l)	184		187	149		172
SC (μmhos)	415	356	382	318	354	362
TDS (mg/l)	270	231	248	207	230	235
Ca "	49		51	51		60
Mg "	16		17	18		21
Na "	7.8		9.0	6.9		7.5
K "	1.3		1.7	1.4		1.8
HCO_3 "	225		229	172		210
SO_4 "	20		34	31		28
NH_4 "	<.01		--	.02		.09
NO_2 & NO_3-N "	<.01		<.01	.08		.06
PO_4 (Ortho)-P "	.006		.034	T		.006
Biological Character						
Total Coliform (colonies/100 mls)	< 1		< 2	7		4
Fecal Coliform (colonies/100 mls)	2		< 2	7		6
Stock present	u	u	u	u	y	y

BASIC DATA RECORD

Station: Little Basin

Location: S 1 T 13S R 7W

Water Year: 1978

Stream Reach Score: 67

Survey Date: 8/16/76

	1977		1978						
Date	10/15	11/13	4/4	4/12	4/19	4/26	5/4	5/10	5/26
Time	1815	1100	1045	1130	1030	1230	1130	1045	1845
Temperature (F°)									
air	55	42	39	37	45	43	31	46	47
water	46	33	37	38	41	43	37	37	55
water (max)	53	47	inst	53	52	54	51	51	64
water (min)	33	32	inst	32	32	32	32	33	33
Precipitation (in)									
Discharge (cfs)									
instant	1.8	ice	1.6	2.6	1.3	6.8	2.6	4.0	3.0
crest stage	3.9	ice	set	5.2	4.6	6.8	9.9	5.6	7.6
Suspended sediment (ppm)	< 5	30	7	23	15	35	37	22	12
Chemical Character									
PH	7.85	7.80				7.71			8.25
ALK ($CaCO_3$) (mg/l)	165	171				152			184
SC (μmhos)	375	373	330	322	415	300	385	352	378
TDS (mg/l)	244	242	214	209	270	195	250	229	246
Ca "	59	60				41			45
Mg "	20	19				11			15
Na "	7.2	6.8				8.4			9.8
K "	1.5	1.4				1.7			1.5
HCO_3 "	201	209				183			221
SO_4 "	30	31				8			14
NH_4 "	.03	.08				.01			.01
NO_2 & NO_3-N "	.09	.09				< .01			.01
PO_4 (Ortho)-P "	.002	T				.012			.015
Biological Character									
Total Coliform (colonies/100 mls)	2	9				2650			1865
Fecal Coliform (colonies/100 mls)	2	< 2				--			< 2
Stock present	u	u	n	n	n	n	n	n	n

BASIC DATA RECORD

Station: Little Basin
Location: S 1 T 13S R 7W
Water Year: 1978

Stream Reach Score: 67
Survey Date: 8/16/76

Date	5/31	6/8	6/14	6/19	6/27	7/19	8/14	9/11
Time	1615	1030	1845	1645	1445	1730	1500	1530
Temperature (F°)								
air	45	61	65	63	69	61	50	41
water	50	52	63	57	63	62	50	44
water (max)	62	68	69	65	67	70	69	63
water (min)	37	37	41	41	41	46	47	38
Precipitation (in)								
Discharge (cfs)								
instant	3.9	2.6	2.5	3.0	3.0	1.8	1.8	2.7
crest stage	3.9	4.0	4.8	3.0	4.2	3.1	2.7	2.7
Suspended sediment (ppm)	24	22	18	20	17	11	24	17
Chemical Character								
PH				8.38		8.20	8.45	8.41
ALK ($CaCO_3$) (mg/l)				180		171	178	158
SC (µmhos)	383	399	362	377	382	387	420	408
TDS (mg/l)	249	259	235	245	248	252	273	265
Ca "				48		47	52	48
Mg "				19		17	17	16
Na "				9.5		7.6	6.4	6.8
K "				1.3		1.3	0.96	2.6
HCO_3 "				216		209	211	188
SO_4 "				25		31	31	30
NH_4 "				<.01		.18	.08	.02
NO_2 & NO_3-N "				<.01		.03	.02	<.01
PO_4 (Ortho)-P "				.034		.010	.008	.005
Biological Character								
Total Coliform (colonies/100 mls)				9530		15800	3400	9100
Fecal Coliform (colonies/100 mls)				6		106	30	43
Stock present	n	n	n	n	n	u	u	n